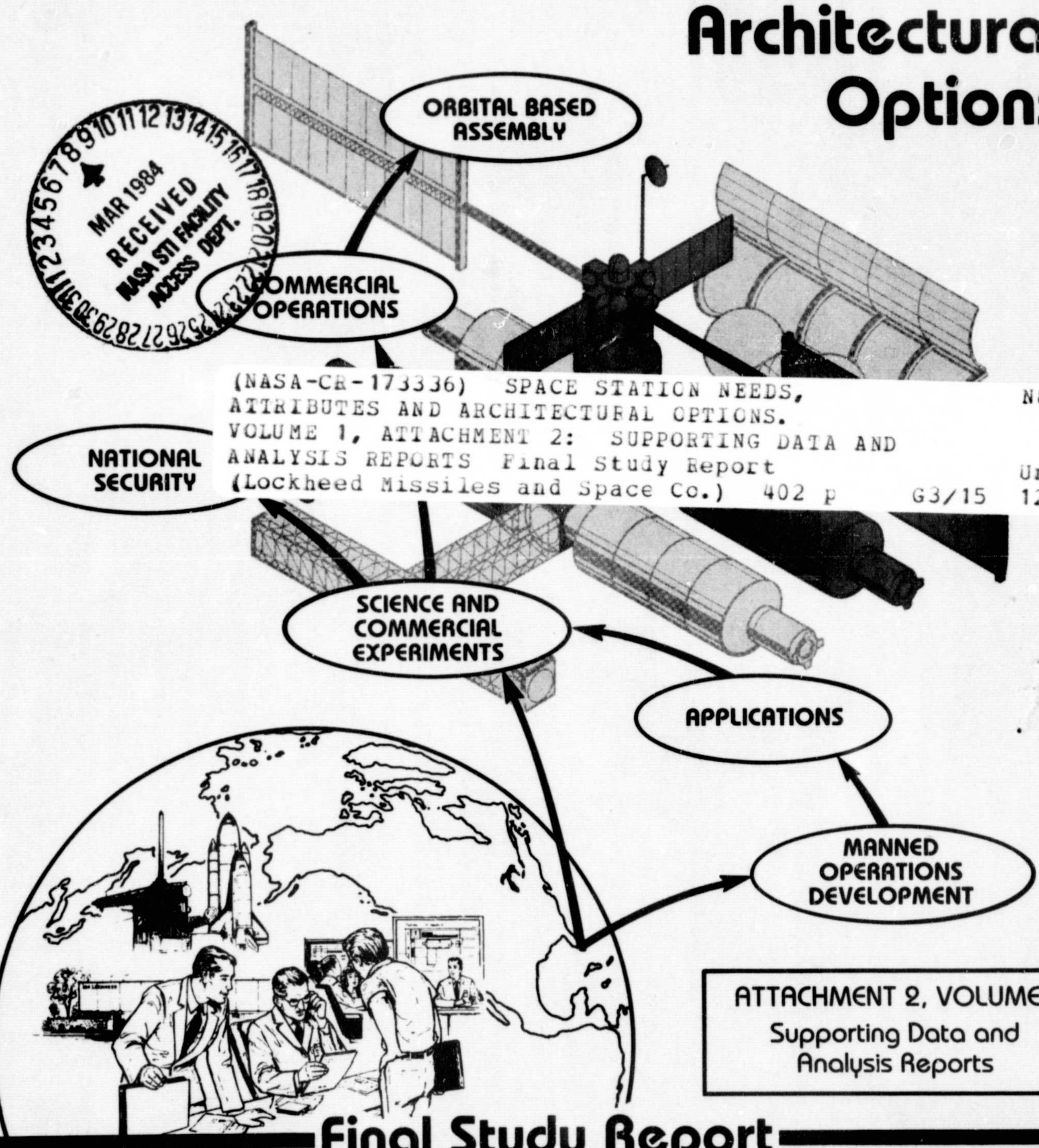
LMSC-D889718
22 APRIL 1983

NASA Space Station Needs, Attributes and Architectural Options



(NASA-CR-173336) SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS. VOLUME 1, ATTACHMENT 2: SUPPORTING DATA AND ANALYSIS REPORTS Final Study Report (Lockheed Missiles and Space Co.) 402 p
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G3/15 12335

ATTACHMENT 2, VOLUME I

Supporting Data and Analysis Reports

Final Study Report

Lockheed Missiles & Space Company, Inc.

LMSC-D889718
22 APRIL 1983

Space Station Needs, Attributes, and Architectural Options

FINAL STUDY REPORT

CONTRACT ~~NAS 3684~~ NASW 3684

22 APRIL 1983

ATTACHMENT 2, VOLUME I
Supporting Data and Analysis Reports

Prepared For **NASA Headquarters Washington, D.C.**

Prepared By *Lockheed Missiles & Space Company, Inc.*
Sunnyvale, California 94088

FINAL STUDY REPORT

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REFERENCE SPACE STATION
EVOLUTION

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REFERENCE SPACE STATION EVOLUTION

An evolutionary space station, initiated in 1990 is discussed in the following pages.

Each step towards the build-up of an end station was based on user requirements when available, a set of scenarios of which some were endorsed covering the five mission categories, and engineering judgements of needs that may surface during the station growth.

Although these steps were logically developed, they are obvious subject to change as more requirements become known, specifically in the National Security and Commercial areas. However, the main reason for this evolution was to obtain a reference cost base which could be used as a gage for total expenditure requirements and would form a base line for the options that will be discussed in this addendum.

Details of design were kept to an absolute minimum as directed in part by the basic contract, and emphasized by the Bob Freitag redirect letter of 23 December 1982.

REFERENCE SPACE STATION

PHASE 1 - Initial station launched in January 1990. (Note: Months are only used to simplify keeping track of the launches and supply requirements).

ORBIT PARAMETERS:

- o Inclination angle 28.5°
- o Altitude 220 miles

This phase of the station is the initial step of the evolutionary space station. It is kept to one (1) shuttle load, does have minimum experiment facility and is planned generally for checkout purposes. Crew rotation, supply logistics, docking techniques, sensor-experiments, and crew related experiments.

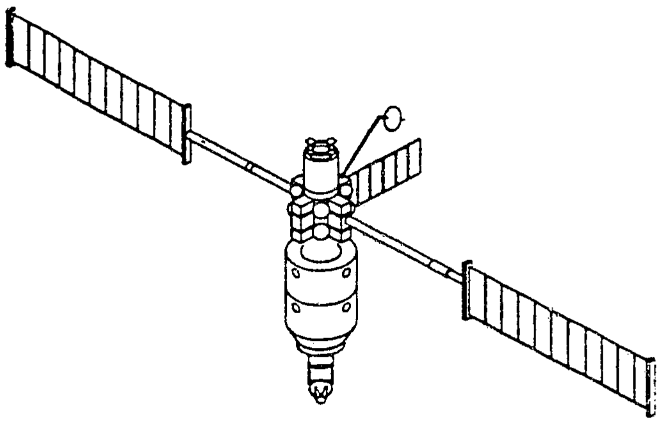
The sensor experiment is a deployable/retractable module servicable in a shirtsleeve environment.

INITIAL SPACE STATION CONSISTS OF:
(FIRST LAUNCH - JANUARY 1990)

- 13 KW POWER SYSTEM
- 3 MAN HABITAT (REGENERATIVE ECLSS)
- RETRACTABLE (TELESCOPIC) EXPERIMENTS TEST BED
- ANTENNA DISCS (1)
- LOGISTIC SUPPLY STORAGE
- 2 DOCKING PORTS
- CONCEPT SHOWN IN FIGURE 1

SHUTTLE LAUNCH REQUIREMENTS:

- ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)
- 3 LOGISTICS SUPPLY SHUTTLE FLIGHTS (EVERY 90 DAYS)



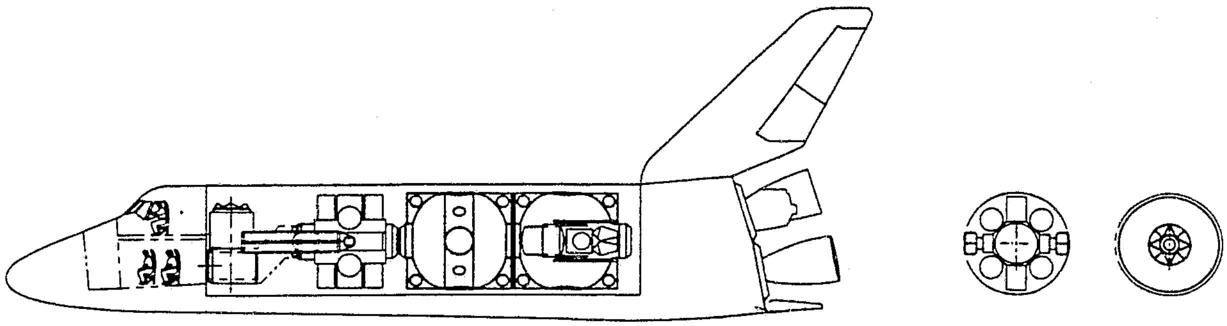


FIG 1

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

FIRST LAUNCH

HABITATION MODULE

STRUCTURE		10,000
MECHANISMS		200
THERMAL CONTROL		2,000
ECLSS		1,500
DATA MANAGEMENT		800
COMMUNICATIONS		500
POWER DISTRIBUTION		1,000
ORDNANCE		50
CREW SYSTEMS		2,000
INSTRUMENTATION		100
CONSUMABLES		8,000
ATT. CONTROL		2,000
	SUBTOTAL	28,150

LAB MODULE

PAYLOAD MODULE

PRIME PAYLOAD		3,000
STRUCTURE		500
MECHANISMS		200
CREW SYSTEMS		200
CONSUMABLES		400-
CREW (3)		600
	SUBTOTAL	4,900

ENERGY MODULE

STRUCTURE		4,000
MECHANISMS		300
THERMAL CONTROL		2,000
ECLSS		100
SOLAR ARRAYS		1,200
POWER		8,500
COMMUNICATIONS		100
CREW SYSTEMS		100
INSTRUMENTATION		200
CONSUMABLES		1,300
	SUBTOTAL	17,800

SHUTTLE ITEMS (DOCKING MODULE ETC)		4,000
	GRAND TOTAL	54,850 LBS

Phase 2 - This is the first additive (launch January 1991) to the initial station which has been proven in its functions and capabilities over a one year period. This phase of the station will still be manned by a crew of 3. Volume is added for more storage and an expansion of experiments.

ADDITIONS TO STATION:
(SECOND LAUNCH JANUARY 1991)

- INTERCONNECT MODULE
- PALLET
- TMS
- SPARES
- CONSUMABLES
- CONCEPT SHOWN IN FIGURE 2

SHUTTLE LAUNCH REQUIREMENTS:

- ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)
- 1 LOGISTICS SUPPLY SHUTTLE FLIGHT

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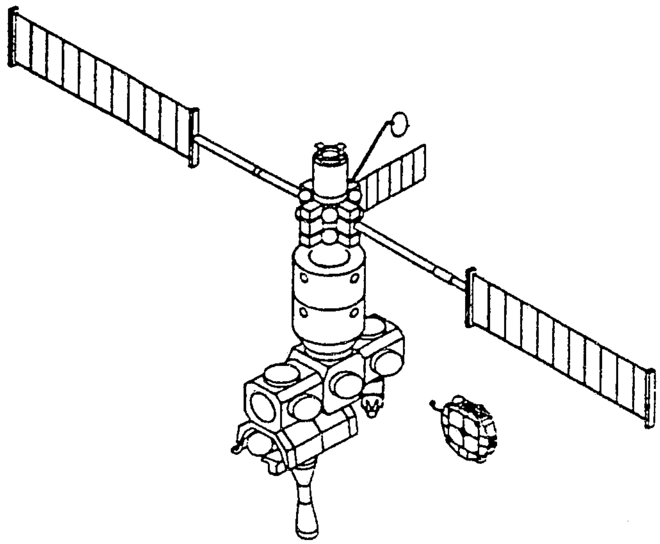

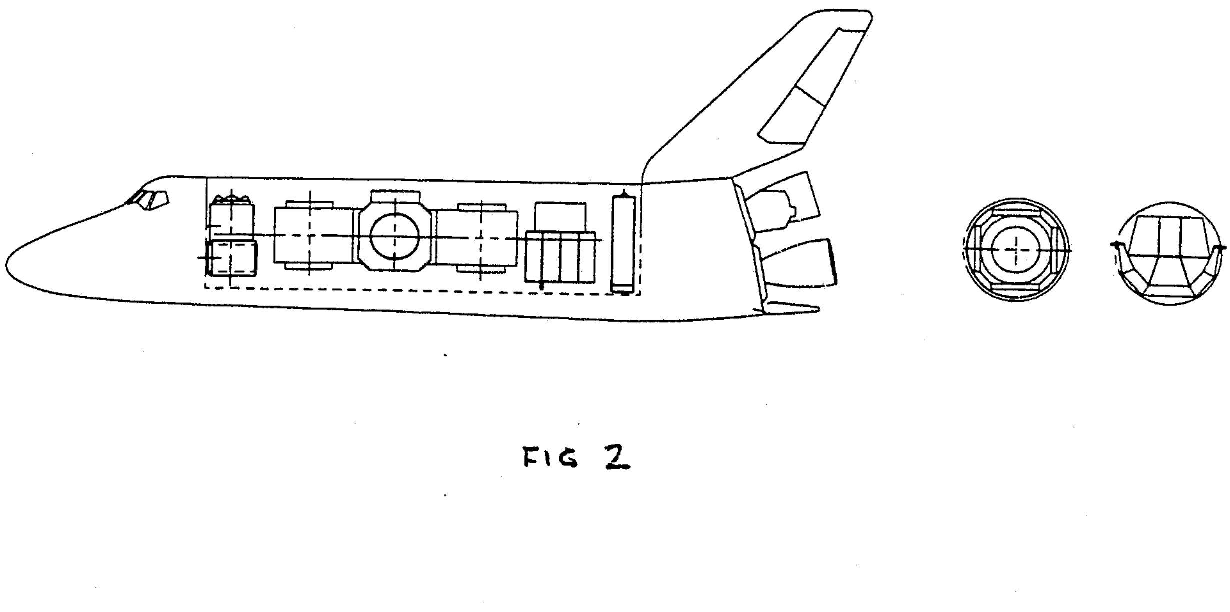

FIG 2

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

SECOND LAUNCH

INTERCONNECT MODULE

STRUCTURE		7,000
MECHANISMS		200
THERMAL CONTROL		100
ECLSS		200
DATA MANAGEMENT		100
COMMUNICAIONS		200
POWER		300
ORDNANCE		50
CREW SYSTEMS		100
INSTRUMENTATION		100
CONSUMABLES		8,000
TANKAGE INSTALLATIONS		2,000
	SUBTOTAL	18,350

TELEOPERATOR MANEUVERING SYSTEM (TMS)

(REF: VOUGHT REPORT)

FIXED WT.		2,545
CONSUMABLES		5,000
DOCKING KIT		281
	SUBTOTAL	7,826
PALLET		2,400
EXPERIMENTS		6,000
	SUBTOTAL	8,400
SHUTTLE ITEMS		4,000
	TOTAL	38,576

Phase 3 - During this phase of the space station there will be 2 launches (July and October 1991) fully dedicated to S S Components. These will be launches 3 and 4. The station capability will be enhanced considerably by the addition of a habitability and life sciences module. Other experiments may be added as their requirements become clear and as space allows.

ADDITION TO STATION:

(THIRD LAUNCH JULY 1991)

- o CENTER STRUCTURE
- o CONSUMABLES
- o CONCEPT SHOWN IN FIG 3

SHUTTLE LAUNCH REQUIREMENTS:

- o ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

THIRD LAUNCH

CENTER STRUCTURE MODULE #1

STRUCTURE		10,000
MECHANISMS		300
THERMAL		200
ECLSS		300
DATA MANAGEMENT		100
COMMUNICATION		100
POWER DIST.		300
ORDNANCE		100
CREW SYSTEMS		300
INSTRUMENTATION		100
ATTITUDE CONTROL		---
TANKAGES		600
PAYLOAD INTERFACE PANELS		1,000
PAYLOADS		6,000
CONSUMABLES		7,000
	SUBTOTAL	26,400
SHUTTLE ITEMS		4,000
	TOTAL	30,400

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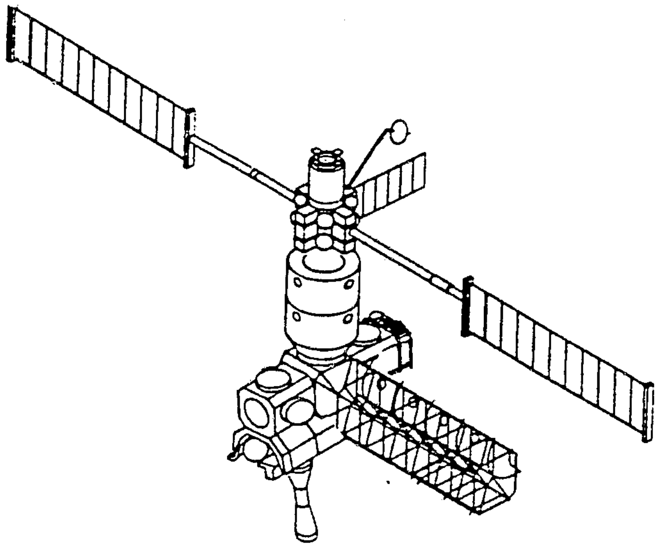


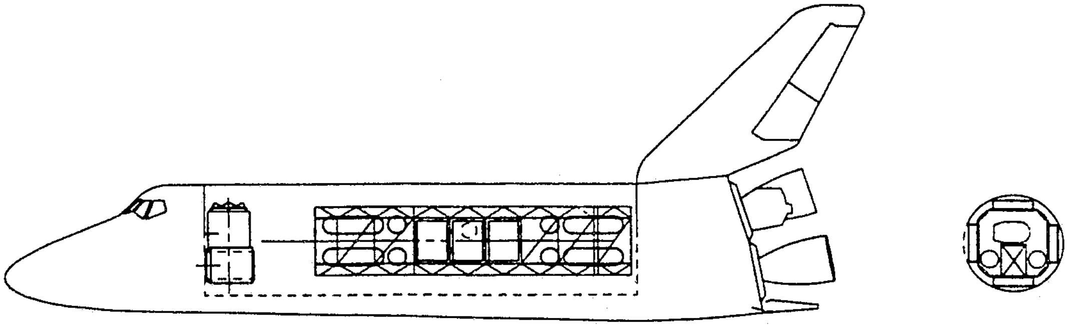


FIG. 3

ADDITION TO STATION:
(FOURTH LAUNCH OCTOBER 1991)

- o HABITABILITY AND LIFE SCIENCES MODULE (REGENERATIVE ECLSS)
- o 3 MEN (FOR TOTAL OF 6 MEN)
- o CONSUMABLES
- o CONCEPT SHOWN IN FIGURE ~~3~~ 4

SHUTTLE LAUNCH REQUIREMENTS:

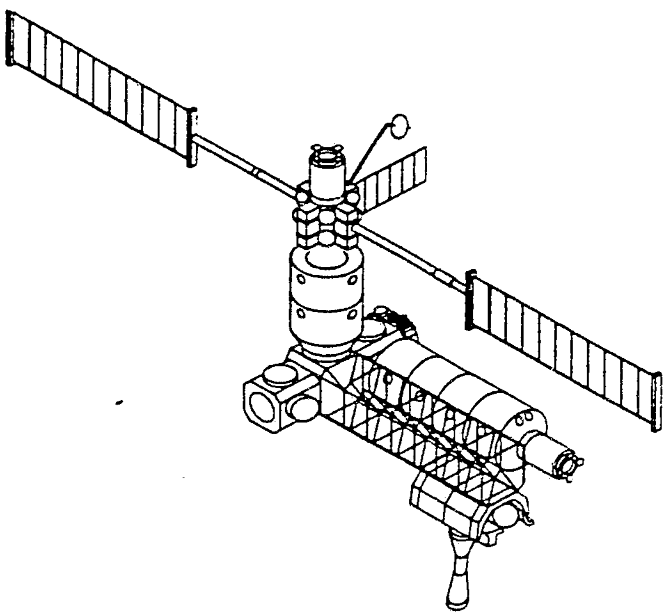
- o ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

<u>FOURTH LAUNCH</u>

<u>HABITATION MODULE #2</u>

STRUCTURE		15,000
MECHANISMS		400
THERMAL		4,000
ECLSS		2,500
DATA MANAGEMENT		1,000
COMMUNICATION		200
POWER DIST.		1,000
ORDNANCE		100
CREW SYSTEMS		2,000
INSTRUMENTATION		200
ATTITUDE CONTROL		--
CONSUMABLES		8,000
	SUBTOTAL	34,400 LBS
AIRLOCK MODULE		4,000 LBS
SHUTTLE ITEMS		4,000 LBS
	GRAND TOTAL	42,400 LBS



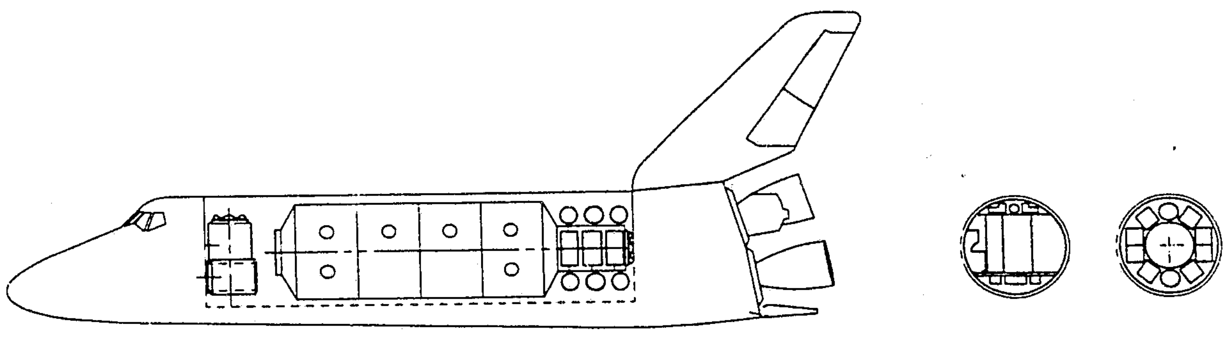


FIG. 4

Phase 4 - This phase of the space station duplicates the phase 3 items to make the station symmetrical, and use less consumables for the control system. The additions here will considerably enhance the station laboratory capability and volume.

ADDITION TO SPACE STATION:
(FIFTH LAUNCH JANUARY 1992)

- o CENTER STRUCTURE
- o CONSUMABLES
- o CONCEPT SHOWN IN FIG 5

SHUTTLE LAUNCH REQUIREMENTS:

- o ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

FIFTH LAUNCH

CENTER STRUCTURE MODULE #2

STRUCTURE		10,000
MECHANISMS		300
THERMAL		200
ECLSS		300
DATA MANAGEMENT		100
COMMUNICATION		100
POWER DIST. & EMER.		300
ORDNANCE		100
CREW SYSTEMS		300
INSTRUMENTATION		100
ATTITUDE CONTROL		---
TANKAGES		600
PAYLOAD INTERFACE PANELS		1,000
PAYLOADS		6,000
CONSUMABLES		8,000
	SUBTOTAL	27,400 LBS
SHUTTLE ITEMS		4,000 LBS
	GRAND TOTAL	31,400 LBS

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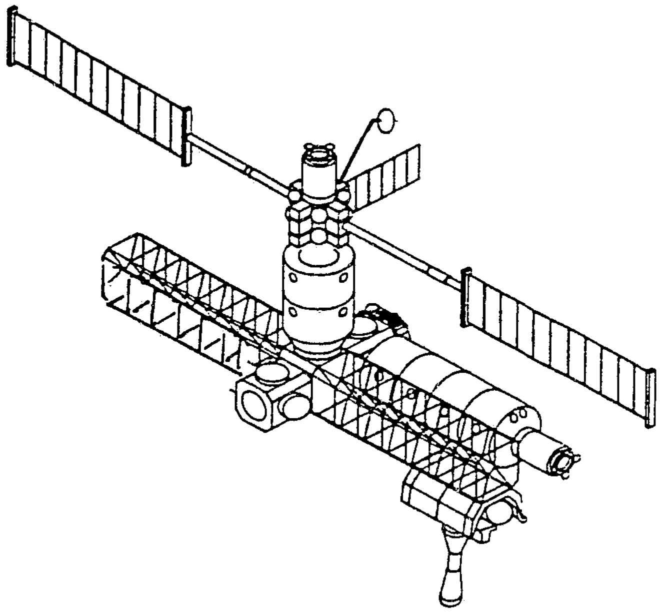

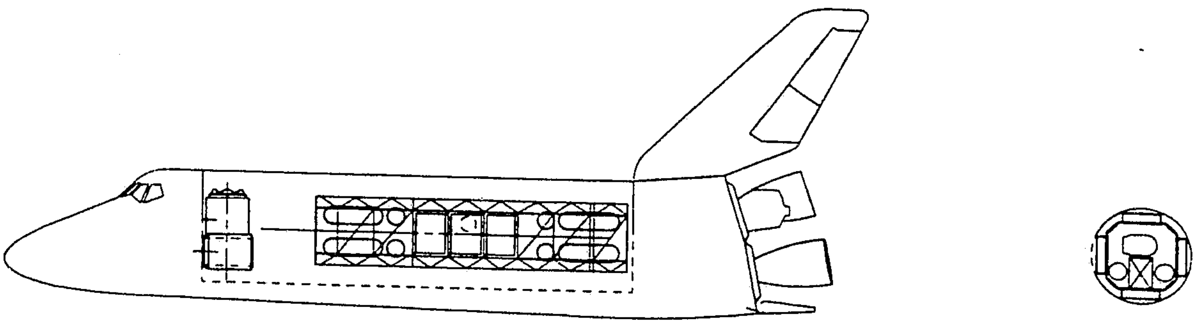

FIG 5

ADDITION TO STATION:
(SIXTH LAUNCH APRIL 1992)

- o SENSOR AND GENERAL USE LABORATORY
- o CONSUMABLES
- o CONCEPT SHOWN IN FIGURE 6

SHUTTLE LAUNCH REQUIREMENTS

- o ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)
- o TWO LOGISTICS SUPPLY SHUTTLE FLIGHTS (EVERY 90 DAYS)

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

SIXTH LAUNCH

SENSOR DEVELOPMENT AND GENERAL WORKSHOP

STRUCTURE		15,000
MECHANISMS		1,000
THERMAL		4,000
ECLSS		3,000
DATA MANAGEMENT		1,500
COMMUNICATION		200
POWER		1,500
ORDNANCE		150
CREW SYSTEMS		1,500
INSTRUMENTATION		100
MACHINE TOOLS		3,000
STORAGE RACKS		1,000
HAND TOOLS		600
	SUBTOTAL	32,550
AIRLOCK MODULE		4,000
SHUTTLE ITEMS		4,000
	TOTAL	40,550

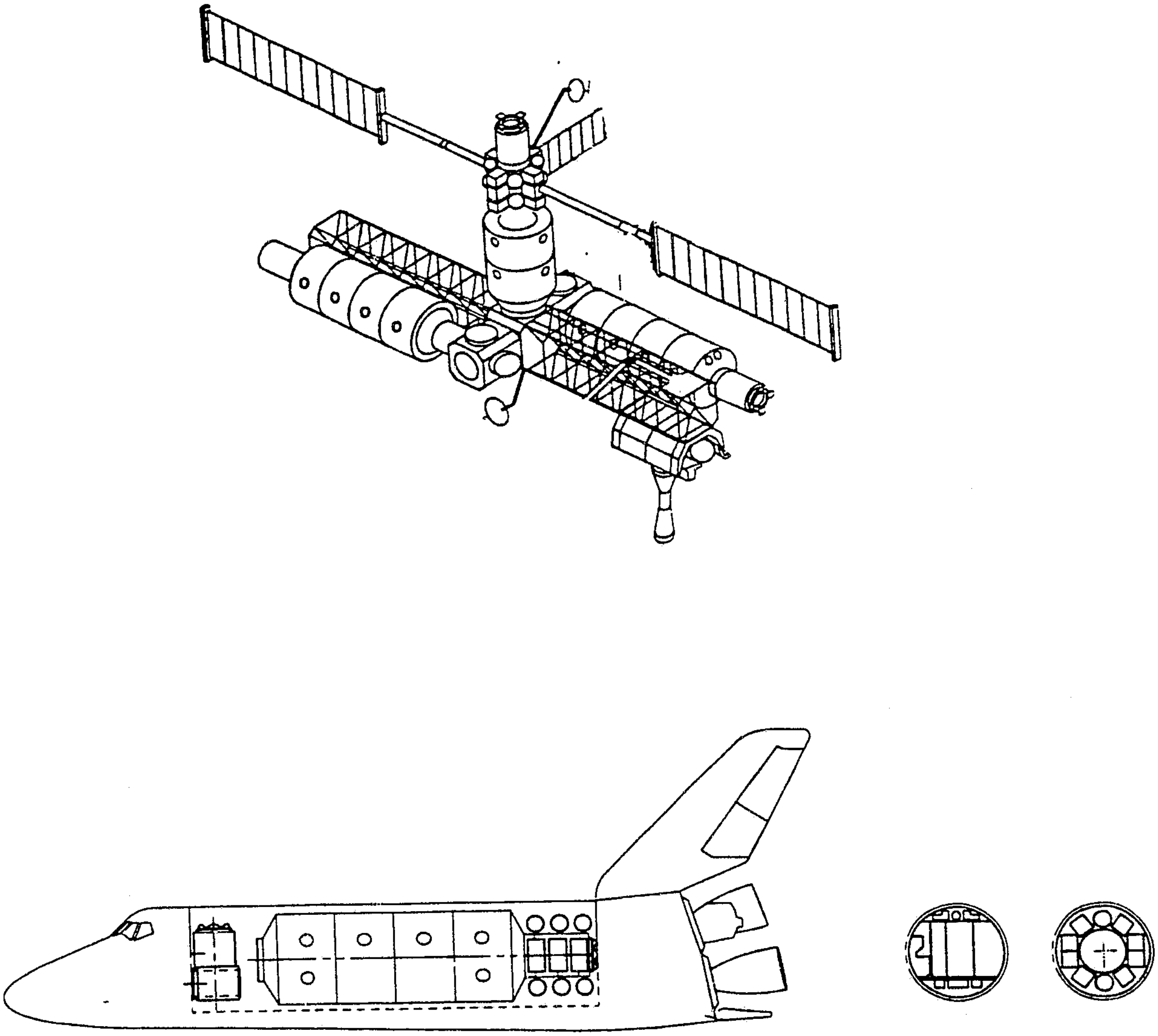

FIG. 6

Phase 5 - During this phase of the space station build-up an OTV capability will be added. This includes structure docking and refuelling devices, and the OTV. The Enlarged Centaur has been considered for this application.

ADDITION TO SPACE STATION:
(SEVENTH LAUNCH JANUARY 1993)

- o CRYOGENIC OTV SUPPORT STRUCTURE
- o OTV HANGAR
- o FUEL STORAGE TANKS
- o RMS
- o TRACKS FOR RMS
- o CONCEPT SHOWN IN FIG 7

SHUTTLE LAUNCH REQUIREMENTS:

- o ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

SEVENTH LAUNCH

CRYOGENIC OTV SUPPORT MODULE

STRUCTURE		8,000
MECHANISMS		400
THERMAL		500
ECLSS		200
DATA MANAGEMENT		200
COMMUNICATION		200
POWER DIST.		300
ORDNANCE		150
CREW SYSTEMS		700
INSTRUMENTATION		150
ATTITUDE CONTROL		--
TANKAGES		2,000
UMBILICALS		400
CONSUMABLES		7,000
	SUBTOTAL	20,200

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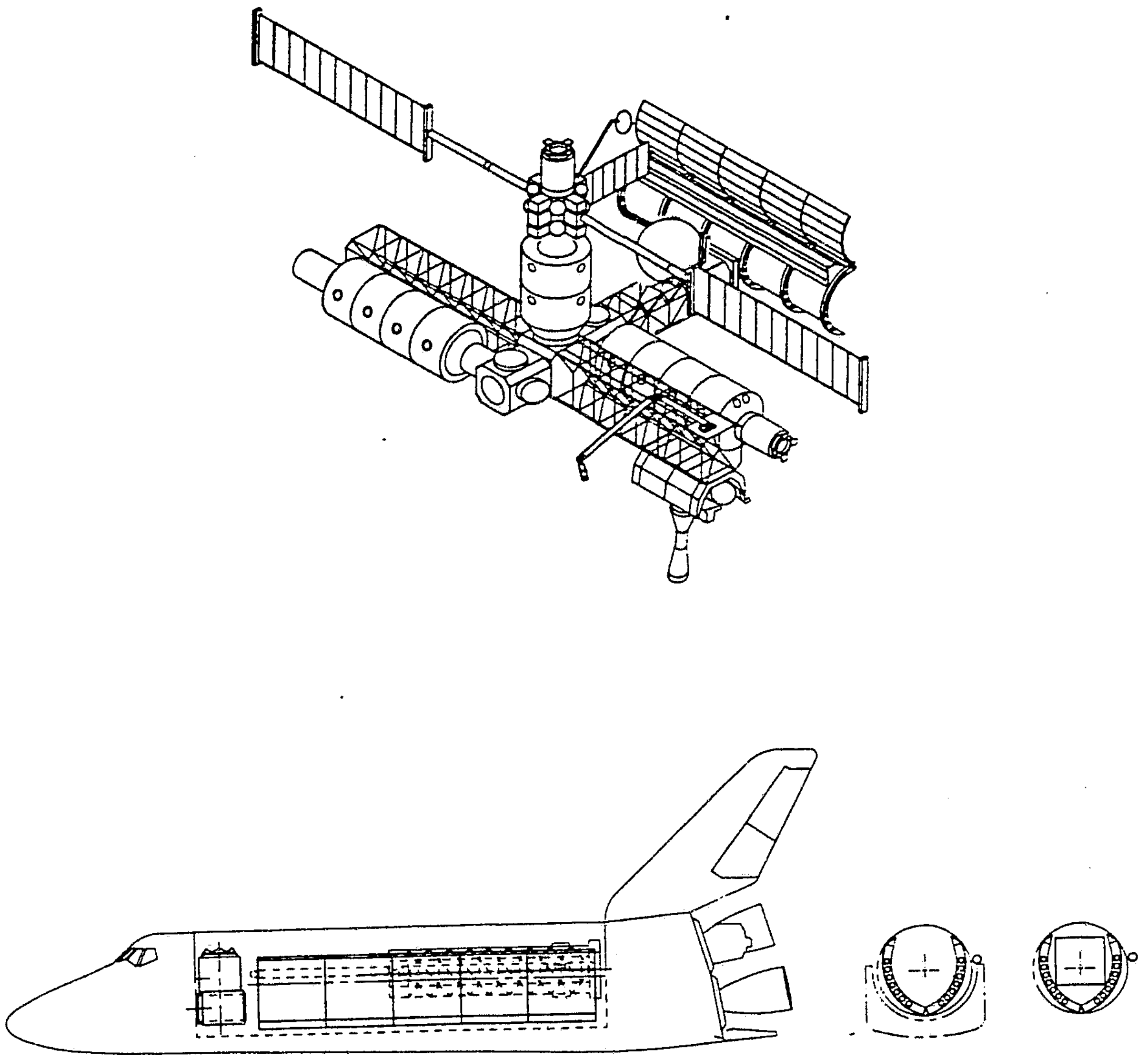

FIG. 7

SEVENTH LAUNCH

CRYOGENIC OTV HANGAR

STRUCTURE		8,000
MECHANISMS		700
THERMAL		500
ECLSS		400
DATA MANAGEMENT		200
COMMUNICATION		100
POWER DIST.		300
ORDNANCE		100
CREW SYSTEMS		200
INSTRUMENTATION		100
ATTITUDE CONTROL		--
TANKAGES		2,000
UMBILICALS		400
PROPELLANT XFER EQ.		400
CONSUMABLES		2,500
	SUBTOTAL	15,900
CRYOGENIC OTV SUPPORT		20,200
SHUTTLE ITEMS		4,000
RMS		1,200
	TOTAL	41,300

ADDITION TO SPACE STATION:
(EIGHTH LAUNCH APRIL 1993)

- o CRYOGENIC OTV
- o ANTENNA DISC
- o CONCEPT SHOWN IN FIGURE 8

SHUTTLE LAUNCH REQUIREMENTS:

- o ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)
- o TWO LOGISTICS SUPPLY SHUTTLE FLIGHTS (EVERY 90 DAYS)

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

EIGHTH LAUNCH

OTV TANKAGE

LO_2 TANK (CAPACITY 30,000 LB)		208
LH2 TANK (CAPACITY 5,000 LB)		310
STRUCTURAL FITTINGS		1,590
PLUMBING		400
UMBILICALS		300
MISC. STRUCTURE		500
MECHANISMS		500
THERMAL		700
ECLSS		200
DATA MANAGEMENT		200
COMMUNICATION		100
POWER		400
ORDNANCE		150
CREW SYSTEMS		500
INSTRUMENTATION		100
CONSUMABLES		842
	TOTAL	7,000
OTV VEHICLE		53,200
COMMUNICATION ANTENNA		400
SHUTTLE ITEMS		2,000
	GRAND TOTAL	62,600

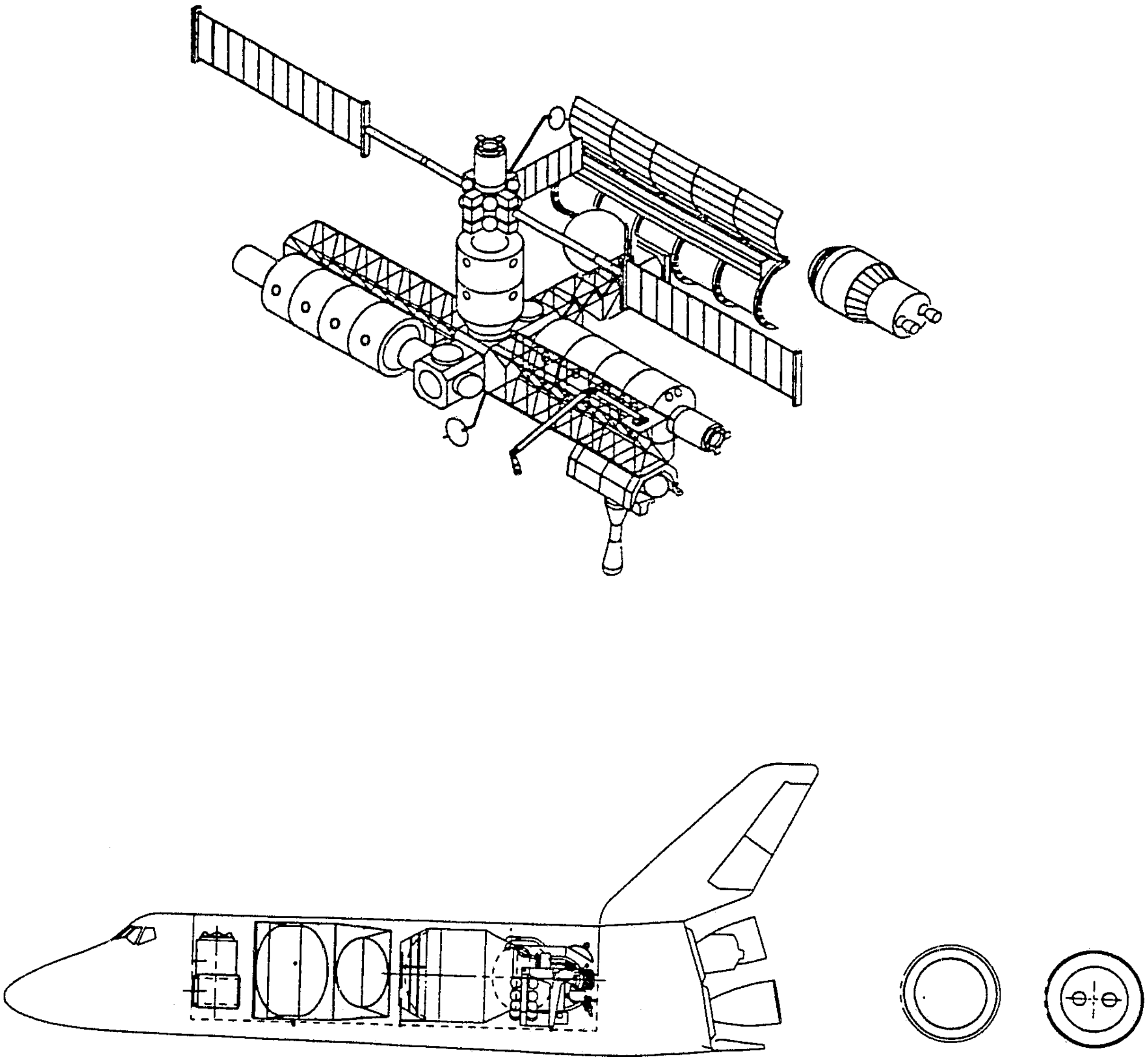

FIG. 8

Phase 6 - A second power module will be added during this phase bringing the total power level to 50 kW. This power load will serve additional experiment requirements and spacecraft servicing.

ADDITION TO SPACE STATION:
(NINTH LAUNCH JANUARY 1994)

- 13 kW POWER SYSTEM (TO MAKE 26 kW TOTAL)
- TMS SUPPORT MODULE
- TMS
- CONCEPT SHOWN IN FIGURE 9

SHUTTLE LAUNCH REQUIREMENTS:

- ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

NINTH LAUNCH		
25 kW POWER SYSTEM		17,800
TMS SUPPORT MODULE		
STRUCTURE		8,000
MECHANISMS		300
THERMAL		300
ECLSS		200
DATA MANAGEMENT		200
COMMUNICATION		200
POWER DIST.		100
ORDNANCE		100
CREW SYSTEMS		400
INSTRUMENTATION		100
ATTITUDE CONTROL		---
TANKAGES		800
UMBILICALS		200
CONSUMABLES		2,000
PROPELLANTS (HYDRAZINE)		10,000
	SUBTOTAL	22,900
SHUTTLE ITEMS		4,000
TMS FIXED WEIGHT		2,545
PROPELLANTS		5,000
DOCKING KIT		281
	SUBTOTAL	7,826
	GRAND TOTAL	52,526

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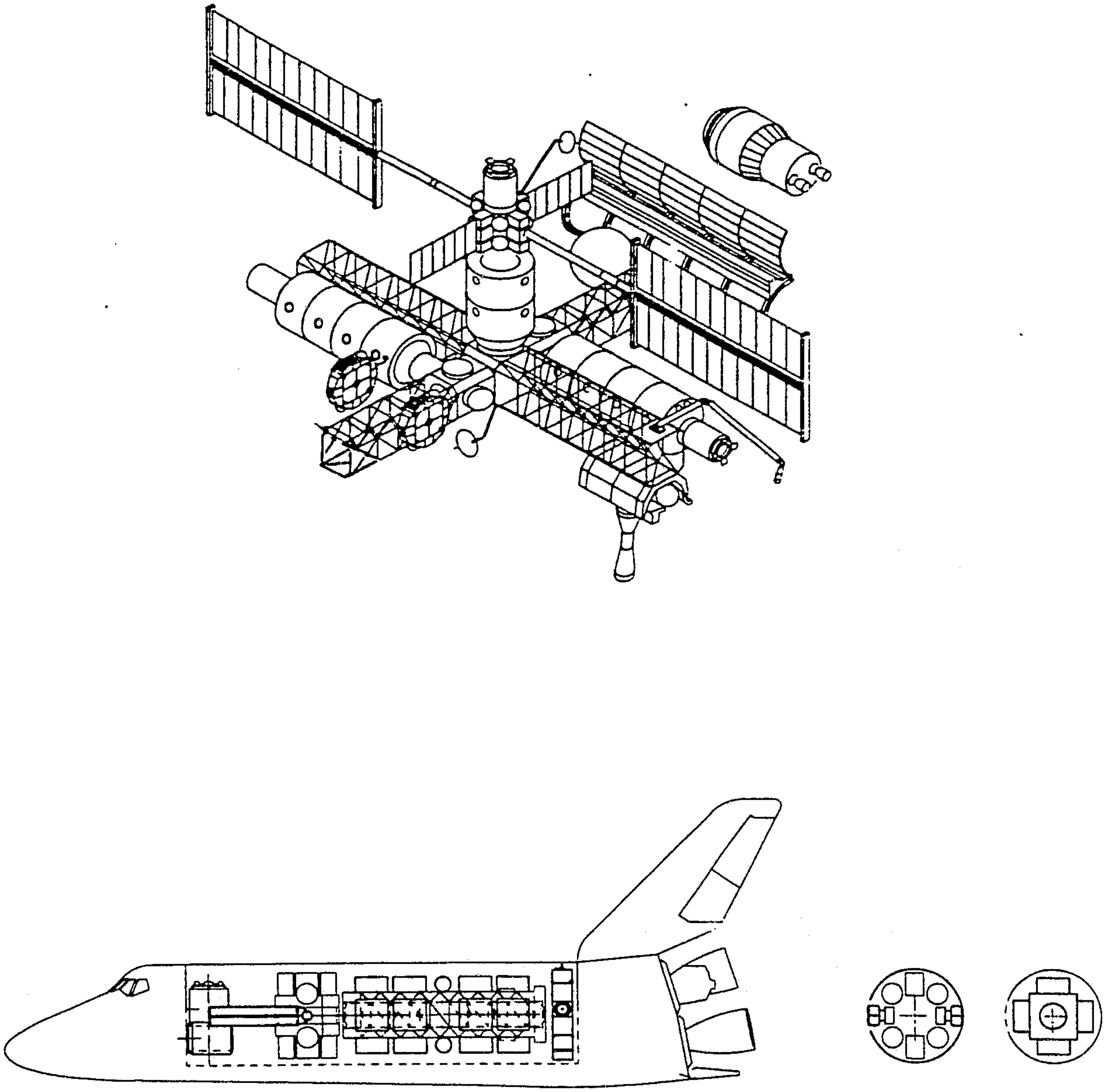


FIG. 9

ADDITION TO SPACE STATION:
(TENTH LAUNCH APRIL 1994)

- o SPACECRAFT SERVICING MODULE
- o RMS TRACKS
- o RMS
- o STORABLE OTV CONSUMABLES
- o CONCEPT SHOWN IN FIGURE 10

SHUTTLE LAUNCH REQUIREMENTS:

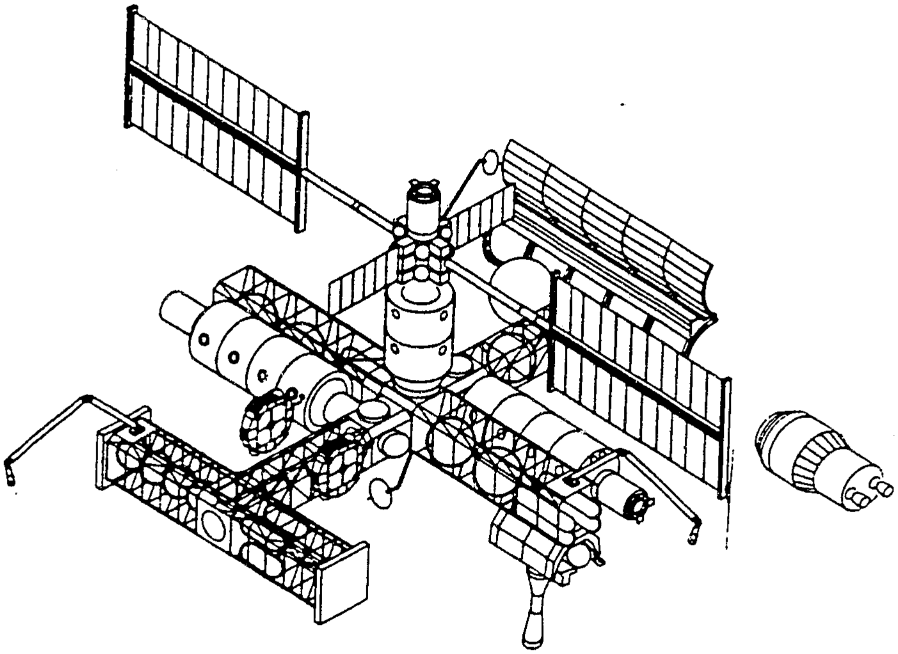
- o ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)
- o THREE SUPPLY SUPPORT SHUTTLE FLIGHTS

SPACE STAION ELEMENTS AND THEIR WEIGHTS:

TENTH LAUNCH

SPACECRAFT SERVICE MODULE

STRUCTURE		8,000
MECHANISMS		800
THERMAL		200
ECLSS		200
DATA MANAGEMENT		200
COMMUNICATION		100
POWER DIST.		400
ORDNANCE		150
CREW SYSTEMS		700
INSTR.		150
ATTITUDE CONTROL		---
TANKAGES		2,000
UMBILICALS		400
CONSUMABLES		6,800
	SUBTOTAL	20,100
RMS	SUBTOTAL	1,200
STORABLE OTV CONSUMABLES	SUBTOTAL	10,000
ATTITUDE CONTROL MODULES	SUBTOTAL	2,000
SHUTTLE ITEMS		3,000
	TOTAL	36,300



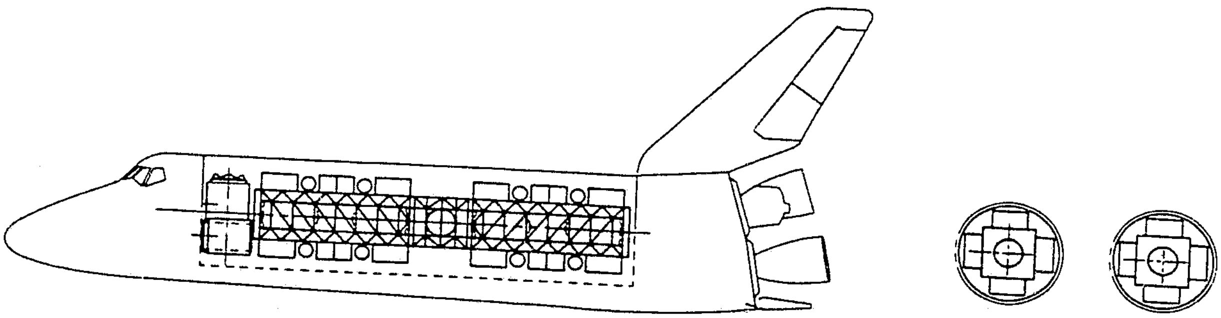


FIG. 10

Phase 7 - During this phase the space station volume will be almost doubled by the addition of a research module and a materials processing laboratory module.

ADDITION TO SPACE STATION:
(ELEVENTH LAUNCH APRIL 1995)

- GENERAL PURPOSE RESEACH MODULE

SHUTTLE LAUNCH REQUIREMENTS:

- ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)
- SEE FIG. 11

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

ELEVENTH LAUNCH

GENERAL PURPOSE RESEARCH MODULE

STRUCTURE		15,000
MECHANISMS		2,000
THERMAL		4,000
ECLSS		2,500
DATA MANAGEMENT		1,500
COMMUNICATION		200
POWER DIST.		1,000
ORDNANCE		100
CREW SYSTEM		1,500
INSTR.		200
ATTITUDE CONTROL		---
TANKAGES		1,000
CONSUMABLES		6,000
SCIENTIFIC EQUIPMENT		4,000
TOOLS		800
	SUBTOTAL	39,800
RMS		1,200
SHUTTLE ITEMS		3,000
	TOTAL	44,000

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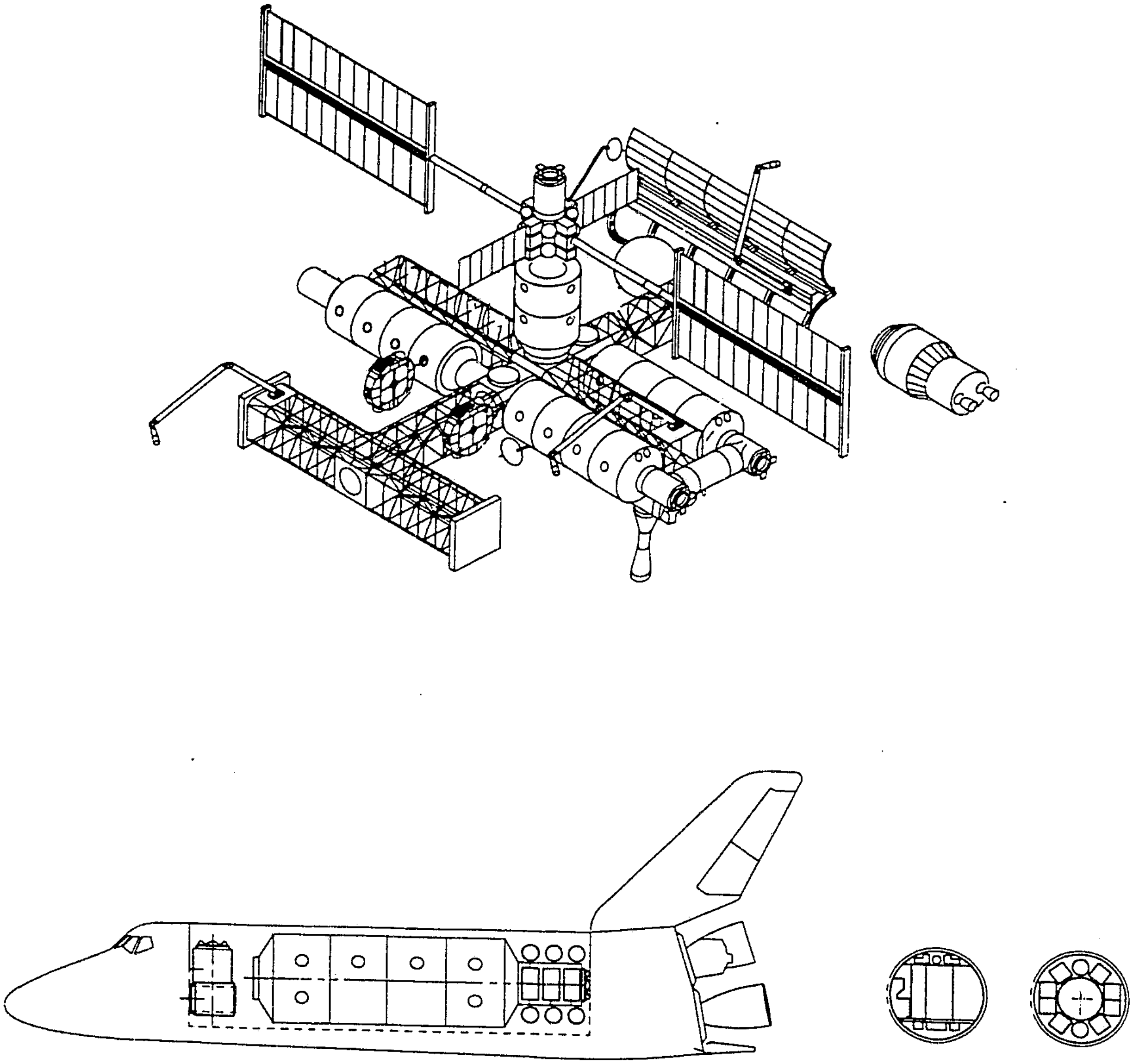

FIG. 11

ADDITION TO SPACE STATION:
(TWELFTH LAUNCH JULY 1995)

- MATERIALS PROCESSING LABORATORY MODULE
- CONCEPT SHOWN IN FIGURE 7)

SHUTTLE LAUNCH REQUIREMENTS:

- ONE SHUTTLE LOAD (SPACE STATION COMPONENTS)
- LOGISTICS SUPPLY EVERY 90 DAYS

SPACE STATION ELEMENTS AND THEIR WEIGHTS:

TWELFTH LAUNCH

MATERIALS PROCESSING MODULE

STRUCTURE		15,000
MECHANISMS		2,000
THERMAL		4,000
ECLSS		2,500
DATA MANAGEMENT		1,000
COMMUNICATION		100
POWER DIST.		2,000
ORDNANCE		100
CREW SYSTEM		1,500
INSTRUMENTATION		200
ATTITUDE CONTROL		---
TANKAGES		2,000
CONSUMABLES		7,000
SPECIAL PURPOSE EQUIPMENT		6,000
TOOLS		1,000
	SUBTOTAL	44,400
RMS (2)		2,400
SHUTTLE ITEMS		3,000
	TOTAL	49,800

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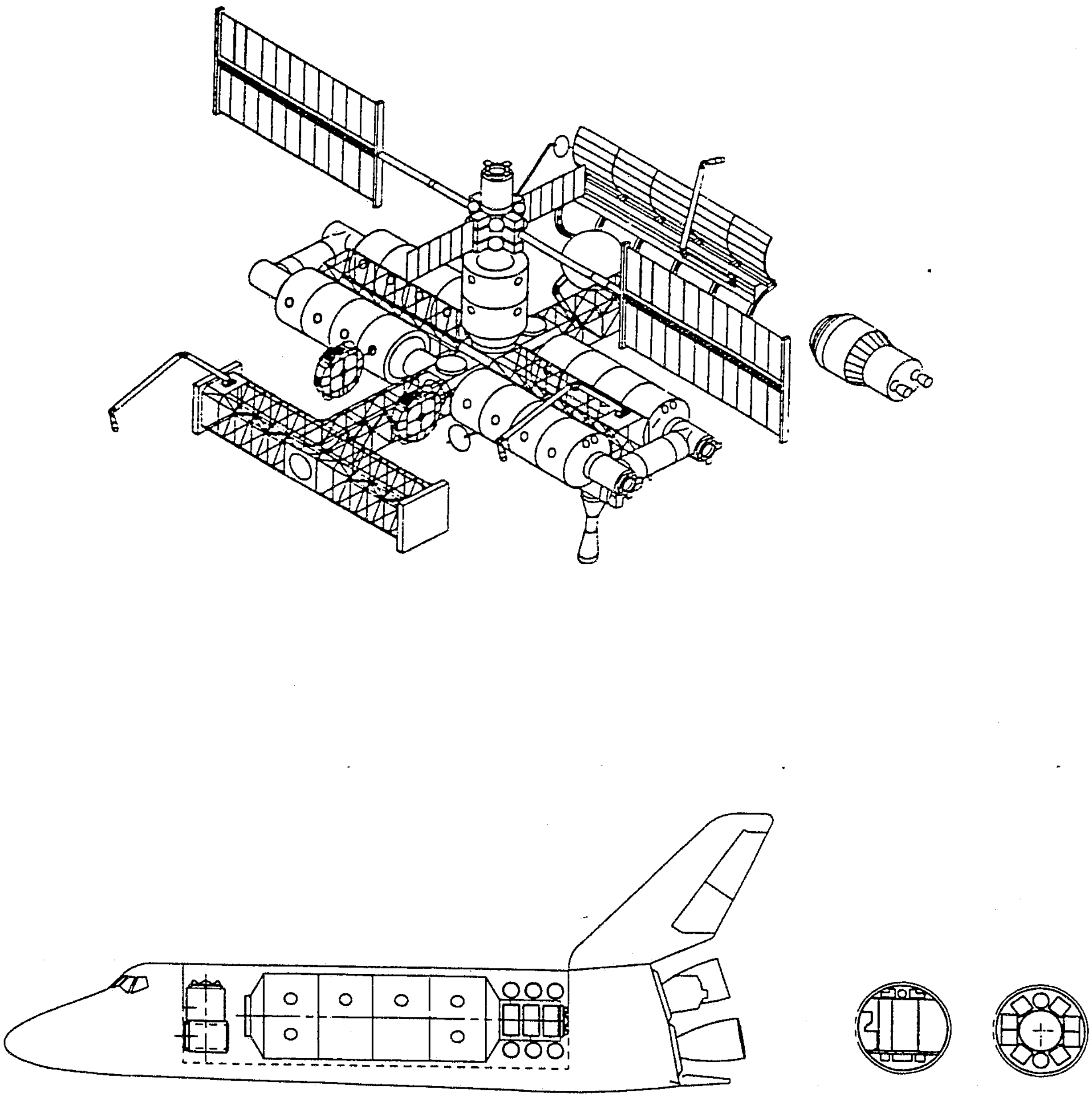

FIG 12

Options to the Space Station Evolution

A number of options have been investigated and their cost compared to the base cost of the space station evolution. Table 1 shows the various other items that were scrutinized.

ITEM NO.	TIME SPAN	DESCRIPTION
1	1995	Nuclear power low level solar
2	1991	Heavy Lift Vehicle vs Shuttle
3	1990	ARIANE vs Shuttle
4	1994	System with free-flyers
5	1993	Two stations 28.5° and polar
6	1990	OTV early (1990) or later (1993)
7	1995	Rescue vehicle, orbital or reentry

REFERENCE STATION BUILD UP LAUNCHES

		STEP 1	STEP 2	STEP 3		STEP 4		STEP 5		STEP 6		STEP 7	
	LAUNCH DATE	JAN '90	JAN '91	JULY '91	OCT '91	JAN '92	APR '92	JAN '93	MAR '93	JAN '94	APR '94	JAN '95	APR '95
	LAUNCH NO.	1	2	3	4	5	6	7	8	9	10	11	12
PRIMARY ELEMENTS	3 MAN HAB	28.15											
	ENERGY MODULE	17.80											
	SENSOR MODULE	4.90											
	INTERCONNECT MODULE		18.35										
	TMS		7.83										
	CENTER STRUCT #1			26.4									
	HABITATION MODULE				30.4								
	AIR LOCK				4.0								
	CENTER STRUCT #2					21.4							
	SENSOR LAB						32.55						
	AIRLOCK MODULE						4.00						
	CRYO OTV SUPPT.							20.2					
	CRYO HANGAR							15.9					
	RMS							1.2					
	OTV TANKAGE								7.0				
	OTV VEHICLE								53.2				
	COMM ANT.								.4				
	25 Kw PWR.									17.8			
	TMS SUPT.MOD									22.9			
	TMS									7.8			
	SPACECRAFT SERVICE										20.1		
	RMS										1.2		
	STORABLE PROPS.										10.0		
	ATT.CONT.MODULES										2.0		
	G.P.RESEARCH											39.8	
	RMS											1.2	
	MATL.PROC.MOD.												44.4
	RMS (2)												2.4
	SHUTTLE ITEMS	4.0	4.0	4.0	4.0	4.0	4.0	4.0	2.0	4.0	3.0	3.0	3.0
	TOTAL LAUNCH V/H	54.85	30.38	30.4	38.4	25.4	40.55	41.3	62.6	52.5	36.3	44.0	49.8

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Approved				Report No

REFERENCE SPACE STATION TOTAL LAUNCH SCHEDULE

STATION BUILD-UP PLUS RESUPPLY

LAUNCH #	CARGO	1990	1991	1992	1993	1994	1995
1	3 MAN LAB	▼					
2	RESUPPLY	▽					
3	RESUPPLY	▽					
4	INTERCONNECT.		▼				
5	RESUPPLY		▽				
6	#1 STRUCT.		▼				
7	6-MAN HAB.		▼				
8	#2 STRUCT			▼			
9	SENSOR WORKSHOP			▼			
10	RESUPPLY			▽			
11	RESUPPLY			▽			
12	OTV SUPPT				▼		
13	OTV VEHICLE				▼		
14	RESUPPLY				▽		
15	RESUPPLY				▽		
16	PWR SYS + TMS SUPT					▼	
17	SPACECRAFT SERV.					▼	
18	RESUPPLY					▽	
19	RESUPPLY					▽	
20	GENERAL PURPOSE LAB						▼
21	MATL PROC. LAB.						▼
22	RESUPPLY						▽
23	RESUPPLY						▽
24	RESUPPLY						▽

▼ STATION BUILD-UP LAUNCHES

▽ RESUPPLY LAUNCHES.

FORM 981 C 362-1

LMSC-D889718

SPACE STATION PROGRAMS

ATTACHMENT 2

SUPPORTING DATA AND ANALYSIS REPORTS

VOLUME I

CONTACT LIST

Lockheed

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LEGEND:

REGIONS:

EA = USA, EAST
EU = EUROPE
MW = USA, MIDWEST
SO = USA, SOUTH
WE = USA, WEST

USER CODES:

CO = COMMERCIAL
I = INTERNATIONAL
LS = LIFE SCIENCES
M = MILITARY
MD = MEDICINE
MP = MATERIAL PROCESSING
O = OPERATIONS
SA = SCIENTIFIC APPLICATIONS
PS = PHYSICAL SCIENCES
S = SCIENTIFIC
T = TECHNOLOGY

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SORTED BY AGENCY, FIRST SCHED VISIT, MEMBER11

AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
	PROF NAPOLITANO		PARIS	EU		GLASER			1-OCT-82	1-OCT-82
3M	J A THWAITS		ST PAUL	MW	MP	GRODZKA			10-NOV-82	
ABBOTT	J K RAAB		CHICAGO,ILL	MW	MP	GRODZKA			10-NOV-82	
ABC	E H RULE		NY,NY	EA	CO	GLASER			10-NOV-82	
AERO	T CRITES		LOS ANGELES	WE	LS	OLCOTT				
AFML	H A JOHNSON	513/255-2232	DAYTON, OH	MW	CO	GRODZKA			13-OCT-82	13-OCT-82
AIAA	T HARTFORD	212/581-4300	NY	EA	CO	GRODZKA			11-JAN-83	11-JAN-83
ALCOA	G K TURNBULL		PITTSBURGH	EA	MP	GRODZKA			10-NOV-82	10-NOV-82
						GRODZKA			13-DEC-82	13-DEC-82
ALCOA	DR W HAUPIN	412/339-6651	ALCOA CTR,PA	EA	CO	GRODZKA			13-JAN-83	13-JAN-83
ALCOA	H PARIS		ALCOA CTR,PA	EA	CO	GRODZKA			13-JAN-83	13-JAN-83
ALLIED	S LEVINSON	201/455-2541	MORRISTOWN	EA	MP	GRODZKA			10-NOV-82	10-NOV-82
									10-JAN-83	10-JAN-83
ALLIED	S LEVINSON	201/455-2541	MORRISTOWN	EA	MP	GRODZKA			10-JAN-83	10-JAN-83
ALLIS-CH	W T FARNSWORTH		APPLETON WI	MW	CO	GLASER			10-NOV-82	
ALPHA IN	J C KORCUBA			EA	CO	GLASER			10-NOV-82	10-NOV-82
AM ELECT	E E TERREY	415/857-9300	PALO ALTO	WE	CO	GRODZKA			2-NOV-82	
AMER CYN	G J SELLA, JR		WARNER, NJ	EA	MP	GRODZKA			10-NOV-82	
AMER HP	J R SAFFORD		NY,NY	EA	MP	GRODZKA			10-NOV-82	
AMER STD	W A MARQUARD		NY,NY	EA	MP	GRODZKA			10-NOV-82	
AMP	DR G CVYANOVICH	717/986-5404	WINSTON-SALE	EA	CO	GLASER			10-NOV-82	10-NOV-82
						GRODZKA			16-DEC-82	16-DEC-82
AMP	R H ZIMMERMAN	919/725-9222	WINSTON-SALE	EA	CO	GRODZKA			16-DEC-82	16-DEC-82
APPLIC E	C E WATERS	312/593-5000	ELKGROVE, IL	MW	CO	GRODZKA			23-NOV-82	
ARCO ELE	R N COTANCH		SHELLYV, IN	MW	MP	GRODZKA			10-NOV-82	
ARGENTIN	C MATAS	202/667-5026	WASH	EA	SA	STRAIGHT			4-OCT-82	
ARIANE	H PFEFFER		PARIS	EU	I	HEKKING			7-DEC-82	7-DEC-82

24-MAR-83 10:39 am
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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
AUSTRAL	D BARNSLEY	202/483-4424	WASH	EA	SA	STRAIGHT			4-OCT-82	15-OCT-82
AUSTRAL	M REICHELT		WASH	EA	CO	STRAIGHT			15-OCT-82	15-OCT-82
						STRAIGHT			7-DEC-82	7-DEC-82
AUSTRAL	M MOIGHNARD		WASH	EA	CO	STRAIGHT			15-OCT-82	15-OCT-82
BABCOX	W M VANNOY		NEW ORLEANS	SO	CO	GLASER			10-NOV-82	
BACTI-CO	DR L GALL	713/664-6702	HOUSTON	SO	MD	GLASER			10-NOV-82	10-NOV-82
						GRODZKA			30-NOV-82	30-NOV-82
BANKAMER	AD ROGERS	213/228-2080	LOS ANGELES	WO	CO	GLASER			26-JAN-83	26-JAN-83
BAXTER	DR. J.THOMAS	312/965-4700	DEERFIELD,IL	MW	MD	GLASER			10-NOV-82	10-NOV-82
						GRODZKA			24-NOV-82	24-NOV-82
BECHTEL	G WANG		SAN FRANCISC	WE	CO	GLASER			26-JAN-83	26-JAN-83
BECHTEL	H B FORSEN		SAN FRANCISC	WE	CO	GLASER			26-JAN-83	26-JAN-83
BECKMAN	W F BALLHAUS		FULLERTON	WE	MP	GRODZKA			10-NOV-82	
BECTON	DR DS METZEL	201/967-3700	RUTHERFORD	EA	MD	GLASER			10-NOV-82	10-NOV-82
									10-JAN-83	10-JAN-83
BELL & H	D N FREY		CHICAGO	MW	MP	GRODZKA			10-NOV-82	
BELL LAB	D REUDINK		MURRAY HILL	EA	CO	GLASER			10-NOV-82	10-NOV-82
BIONET	A PEARSON		HAMPTON VA	EA	LS	OLCOTT	RUDIGER		14-SEP-82	14-SEP-82
BIOTECH	J PARKER, JR		WASH	EA	CO	STRAIGHT			13-OCT-82	
BORDEN	J MARINO	513/782-6260	CINN OH	MW	MP	GRODZKA			15-OCT-82	15-OCT-82
BORG-WAR	W H WELTYK	312/322-8554	CHICAGO	MW	MP	GRODZKA			18-OCT-82	18-OCT-82
BRAZIL	U LIMA	202/797-0240	WASH	EA	SA	STRAIGHT			4-OCT-82	13-OCT-82
						STRAIGHT			7-DEC-82	7-DEC-82
BRIG HOS	H SHERMAN			EA	MD	GLASER			10-NOV-82	10-NOV-82
BROOKS	H C WEBSTER		HATFIELD, PA	EA	CO	GLASER			10-NOV-82	
BUR STDS	DR J MANNING	301/921-3354	MARYLAND	EA	CO	GRODZKA			15-DEC-82	15-DEC-82
BUR STDS	DR L TESTARDI		MARYLAND	EA	CO	GRODZKA			15-DEC-82	15-DEC-82
BUR STDS	DR CEZAIRLEYAN		MARYLAND	EA	MP	GRODZKA			15-DEC-82	15-DEC-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
BUR STDS	DR M MOLDOVER		MARYLAND	EA	MP	GRODZKA			15-DEC-82	15-DEC-82
CARRIER	R F ALLEN		SYRACUSE	EA	CO	GLASER			10-NOV-82	
CBS	T H WYMAN		NY,NY	EA	CO	GLASER			10-NOV-82	
CELANESE	DR E WHEELER	214/689-4000	DALLAS	SO	MP	GRODZKA			25-OCT-82	25-OCT-82
CHEM SPE	R ENGEL	202/872-8110	WASH DC	EA	CO	GRODZKA			17-NOV-82	
CHEVRON	K T DERR		SAN FRANCISC	WE	MP	GRODZKA			10-NOV-82	
CIN MILA	R C MESSENGER	513/841-8100	CINCINNATI	MW	CO	GRODZKA			14-OCT-82	
CINC INC	R BURNS	513/367-7601	CINN OH	MW	MP	GRODZKA			15-OCT-82	15-OCT-82
COMM DEV	C A GREATHOUSE	203/323-3143	STAMFORD CN	EA	CO	GRODZKA			18-NOV-82	
COMM MET	B ROMBERG	214/631-4120	DALLAS	SO	MP	GRODZKA			26-OCT-82	26-OCT-82
COMTECH	J ROSENBLUM	516/231-5454	SMITHTOWN, N	EA	CO	GRODZKA			19-NOV-82	
CON ALUM	K HULLIGER	314/851-7633	ST LOUIS	MW	CO	GRODZKA			22-NOV-82	22-NOV-82
CONGRESS	DR F TOONEY		WASH	EA		FORSBERG	STEGMAN	HUNTER	27-OCT-82	27-OCT-82
CONSULT	M RAPHAEL		PALO ALTO	WE	CO	GLASER			26-JAN-83	26-JAN-83
CORN GLA	RG ACKERMAN	607/974-6789	CORNING	EA	MP	GRODZKA			10-NOV-82	10-NOV-82
						GRODZKA			13-DEC-82	13-DEC-82
CORN GLA	J R HUTCHINS		CORNING	EA	MP	GRODZKA			13-DEC-82	13-DEC-82
CORN GLA	DR G SMITH		CORNING	EA	MP	GRODZKA			13-DEC-82	13-DEC-82
CORN GLA	T G GARDNER		CORNING	EA	MP	GRODZKA			13-DEC-82	13-DEC-82
CORN GLA	WM BALDIN		CORNING	EA	MP	GRODZKA			13-DEC-82	13-DEC-82
CRANE	R J SALTER		NY,NY	EA	CO	GLASER			10-NOV-82	
CULLINAN	J G BLAKE			EA	CO	GLASER			10-NOV-82	10-NOV-82
DARPA	LC R MC CORMICK	202/697-4436	PENTAGON	EA	M	FORSBERG	STEGMAN	HUNTER	16-SEP-82	16-SEP-82
						STEGMAN	P. SMITH		28-OCT-82	28-OCT-82
DARPA	LC W O'HERN		PENTAGON	EA	M	FORSBERG			16-SEP-82	
DARPA	COL G KUROWSKI		PENTAGON	EA	M	FORSBERG	HUNTER	STEGMAN	9-MAR-83	9-MAR-83
DART-KRA	J WHITE	312/998-3702	CHICAGO	MW	CO	GRODZKA			23-NOV-82	23-NOV-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
DAY MALL	DR Y TELANG	513/278-5215	DAYTON	MW	MP	GRODZKA			12-OCT-82	12-OCT-82
DEA	S GREEN	703/235-1132	FAIRFAX,VA	EA	SA	STRAIGHT			15-OCT-82	18-OCT-82
DEERE	R A HANSON		MOLINE ILL	MW	MP	GRODZKA			10-NOV-82	
DELMED	A KHOURY		CANTON, MA	EA	MD	GLASER			10-NOV-82	
DEP COMM	S KOUMANEWS	202/235-9761	WASH	EA	M	STRAIGHT			16-SEP-82	16-SEP-82
DFVLR	DR H SCHEUTZ		COLOGNE	EU	I	HEKKING			14-DEC-82	14-DEC-82
DFVLR	H KOCHAN		COLOGNE	EU	I	HEKKING			14-DEC-82	14-DEC-82
DFVLR	H LAENGLE		COLOGNE	EU	I	HEKKING			14-DEC-82	14-DEC-82
DIA	G WARNER	202/755-3750	HDQTR	EA	M	FORSBERG	STEGMAN		29-SEP-82	29-SEP-82
						P. SMITH	HUNTER		28-OCT-82	28-OCT-82
DIG EQUI	K H OLSEN		MAYNARD MA	EA	CO	GLASER			10-NOV-82	
DOD	CO FORSYTHE	202/697-8157	PENTAGON	EA	M	FORSBERG	STEGMAN	HUNTER	13-SEP-82	13-SEP-82
						FORSBERG	P. SMITH		14-OCT-82	14-OCT-82
						FORSBERG	STEGMAN	P. SMITH	28-OCT-82	28-OCT-82
						FORSBERG	P. SMITH	HUNTER	17-NOV-82	17-NOV-82
DORNIER	W PITTELKOW		MUNICH	EU	I	HEKKING			10-DEC-82	10-DEC-82
DORNIER	G RAUSCH		MUNICH	EU	I	HEKKING			10-DEC-82	10-DEC-82
DORNIER	DR A SKOOG		MUNICH	EU	I	HEKKING			10-DEC-82	10-DEC-82
DORNIER	R REICHERT		MUNICH	EU	I	HEKKING			10-DEC-82	10-DEC-82
DOW CHEM	P F OREFFICE		MIDLAND MI	MW	MP	GRODZKA			10-NOV-82	
DOW JONE	L O'DONNELL		NY,NY	EA	CO	GLASER			10-NOV-82	
DRESSER	J R BROWN JR		DALLAS	SO	CO	GLASER			10-NOV-82	
DUPONT	R E MECKERT		WILMINGTON	EA	MP	GRODZKA			10-NOV-82	
DURIRON	RC SHENK	513/226-4359	DAYTON	MW	MP	GRODZKA			12-OCT-82	12-OCT-82
EASTMAN	C H CHANDLER		ROCHESTER	EA	MP	GRODZKA			10-NOV-82	
EG&G	B J O'KEEFE	617/237-5100	WELLESLEY,MA	EA	CO	GRODZKA			9-NOV-82	
ELI LILL	R D WOOD				MP	GRODZKA			10-NOV-82	
EMER ELE	W G NUSBAUM	314/553-2000	ST LOUIS	MW	CO	GRODZKA			15-OCT-82	

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
ENTERRA	J M BALLENGER	215/293-9500	RADNOR,PA	NW	CO	GRODZKA			8-NOV-82	
ERNO	H ERSFELD		BREMEN	EU	I	HEKKING			13-DEC-82	13-DEC-82
ERNO	DR H KAPPLER		BREMEN	EU	I	HEKKING			13-DEC-82	13-DEC-82
ERNO	W WIENSS		BREMEN	EU	I	HEKKING			13-DEC-82	13-DEC-82
ERNO	P KUNIGK		BREMEN	EU	I	HEKKING			13-DEC-82	13-DEC-82
ESA	DR D SHAPLAND		PARIS	EU	I	FORSBERG	HEKKING		1-SEP-82	1-SEP-82
						HEKKING			7-DEC-82	7-DEC-82
ESA	J COLLET		PARIS	EU	I	FORSBERG	HEKKING		15-SEP-82	15-SEP-82
ESA	G PETERS		PARIS	EU	I	HEKKING			7-DEC-82	7-DEC-82
ESA	H PFEFFER		PARIS	EU	I	HEKKING			7-DEC-82	7-DEC-82
ESA	A PEDERSEN		NOORDWYK	EU	I	HEKKING			23-DEC-82	23-DEC-82
ESA(ESTE	W NELLESEN		PARIS	EU	I	HEKKING			7-DEC-82	7-DEC-82
ESA(EURE	R MORY		PARIS	EU	I	HEKKING			7-DEC-82	7-DEC-82
EXXON	H C KAUFMAN		NY,NY	EA	MP	GRODZKA			10-NOV-82	
EXXON	DR H HOPKINS	713/965-4636	HOUSTON	SO	CO	GRODZKA			29-NOV-82	29-NOV-82
EXXON	DR D DAVIDSON	713/965-4636	HOUSTON	SO	CO	GRODZKA			29-NOV-82	29-NOV-82
FENWAL	G S FREEMAN		ASHLAND MA	EA	CO	GLASER			10-NOV-82	
FISCHER	J H TOLSON		WARMINSTER	EA	CO	GLASER			10-NOV-82	
FLOUR	W GREEN	714/975-2222	IRVINE	WE	CO	GLASER			26-JAN-83	26-JAN-83
FOKKER	DR RJ VANDUINEN		SCHIPHOL	EU	I	HEKKING			15-DEC-82	15-DEC-82
FOKKER	RMA DE WIT	SCHIPHOL	SCHIPOL	EU	I	HEKKING			15-DEC-82	15-DEC-82
FOKKER	M RENS		SCHIPHOL	EU	I	HEKKING			15-DEC-82	15-DEC-82
FOKKER	J VANDECOPELLO		SCHIPHOL	EU	I	HEKKING			15-DEC-82	15-DEC-82
FOKKER	P VAN DER VOORT		SCHIPHOL	EU	I	HEKKING			15-DEC-82	15-DEC-82
FORBES	H S FORBES		NY,NY	EA	CO	GLASER			10-NOV-82	

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
FORD AER	H HOCKEIMER		DETROIT	MW	CO	GLASER			10-NOV-82	
FOXBORO	C I W BAXTER		FOXBORO MA	EA	CO	GLASER			10-NOV-82	
GE	R HESSELBACHER		FAIRFIELD	EA	MP	GRODZKA			10-NOV-82	10-NOV-82
GOULD	E C GUERRI	312/640-4414	ILLINOIS	MW	CO	GRODZKA			19-OCT-82	19-OCT-82
GTE LABS	DR W MCNEIL		STAMFORD	EA	CO	GLASER			10-NOV-82	10-NOV-82
GTE LABS	DR P CUKOR		STAMFORD	EA	MP	GRODZKA			10-NOV-82	10-NOV-82
GTE PROD	C P SMITH			EA	CO	GLASER			10-NOV-82	10-NOV-82
GTE SAT	G ALLEN			EA	CO	GLASER			10-NOV-82	10-NOV-82
GTS	G PARDOE		LONDON	EU	I	HEKKING			16-DEC-82	16-DEC-82
					I	HEKKING			24-JAN-83	24-JAN-83
GTS	DR W STEPHENS		LONDON	EU	I	HEKKING			16-DEC-82	16-DEC-82
					I	HEKKING				
GTS	S DAUNCEY		LONDON	EU	I	HEKKING			16-DEC-82	16-DEC-82
					I	HEKKING			26-JAN-83	26-JAN-83
HERCULES	W R MARTIN	202/223-8590	WASH DC	EA	CO	GRODZKA			10-NOV-82	10-NOV-82
						GRODZKA			15-DEC-82	15-DEC-82
HEW PACK	J A YOUNG		PALO ALTO	WE	MP	GRODZKA			10-NOV-82	
HONEYWEL	J J RENIER		MINNEAPOLIS	MW	MP	GRODZKA			10-NOV-82	
HUGHES	E M GALLE	713/924-2331	HOUSTON	SO	MP	GRODZKA			28-OCT-82	28-OCT-82
						GRODZKA			30-NOV-82	30-NOV-82
HUGHES	S R SCALES	713/924-2331	HOUSTON	SO	MP	GRODZKA			30-NOV-82	30-NOV-82
HUGHES	D G ALEXANDER		HOUSTON	SO	MP	GRODZKA			30-NOV-82	30-NOV-82
HUGHES	T ROSENMAYER		HOUSTON	SO	MP	GRODZKA			30-NOV-82	30-NOV-82
IBM	L R MYRICK		PRINCETON,NJ	EA	MD	GLASER			10-NOV-82	
IBM	J R OPEL		ARMONK NY	EA	MP	GRODZKA			10-NOV-82	
INCO US	J M PAGE		NY,NY	EA	MP	GRODZKA			10-NOV-82	
INDIA	R DESPHANDE	202/265-5050	WASH	EA	SA	STRAIGHT			4-OCT-82	14-OCT-82
INDIA	S SETTY		WASH	EA	SA	STRAIGHT			14-OCT-82	14-OCT-82
						STRAIGHT			7-DEC-82	7-DEC-82

SORTED BY AGENCY, FIRST SCHED VISIT, MEMBER11 .

AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
INGERSOL	D C GARFIELD		WOODCLIFF NJ	EA	CO	GLASER			10-NOV-82	
ITALY	G RINELLI	202/328-5500	WASH	EA	SA	STRAIGHT			4-OCT-82	14-OCT-82
ITEK	F J GILLIGAN			EA	CO	GLASER			10-NOV-82	10-NOV-82
J & J	D R CLARE		KALAMAZOO	MW	MP	GRODZKA			10-NOV-82	
JAPAN	H ISIDA	202/234-2266	WASH	EA	SA	STRAIGHT			4-OCT-82	13-OCT-82
JAPAN	T INADA	202/234-2266	WASH	EA	SA	STRAIGHT			13-OCT-82	13-OCT-82
JOHNSON	J E BURKE		NEW BRUNS	EA	MD	GLASER			10-NOV-82	
JPL	DR D O'HANDLEY		PASADENA	WE	LS	OLCOTT	RUDIGER		8-MAR-83	8-MAR-83
JPL	C BERGSTROM		PASADENA	WE	LS	OLCOTT	RUDIGER		8-MAR-83	8-MAR-83
JPL	C GRIFFIN		PASADENA	WE	LS	OLCOTT	RUDIGER		8-MAR-83	8-MAR-83
JPL	J HOSHIZAKI		PASADENA	WE	LS	OLCOTT	RUDIGER		8-MAR-83	8-MAR-83
JPL	G NELSON		PASADENA	WE	LS	OLCOTT	RUDIGER		8-MAR-83	8-MAR-83
JPL	G PETERSON		PASADENA	WE	LS	OLCOTT	RUDIGER		8-MAR-83	8-MAR-83
JPL	M SINGER		PASADENA	WE	LS	OLCOTT	RUDIGER		8-MAR-83	8-MAR-83
JPL	K KAPLAN	213/354-3624	PASADENA	WE	T	BENE	FORSBERG	STEGMAN	16-MAR-83	16-MAR-83
JPL	DR J HIGH		PASADENA	WE	T	BENE	FORSBERG	STEGMAN	16-MAR-83	16-MAR-83
JPL	S SZIRMAY		PASADENA	WE	T	BENE	FORSBERG	STEGMAN	16-MAR-83	16-MAR-83
JPL	D PIVITROTTO		PASADENA	WE	T	BENE	FORSBERG	STEGMAN	16-MAR-83	16-MAR-83
JPL	R DICKINSON		PASADENA	WE	T	BENE	FORSBERG	STEGMAN	16-MAR-83	16-MAR-83
KAISER	C C MAIER		OAKLAND	WE	MP	GRODZKA			10-NOV-82	
KAISER	D SQUIRE		OAKLAND	WE	CO	GRODZKA			26-JAN-83	26-JAN-83
KDI	M CLARK	513/943-2000	CINN OH	MW	MP	GRODZKA			15-OCT-82	15-OCT-82
KEYSTONE	D KELLER			EA	CO	GLASER			10-NOV-82	10-NOV-82
L-O-F	F W SCHRIVER		TOLEDO	MW	MP	GRODZKA			10-NOV-82	
LAHEY	W A CURBY			EA	MD	GLASER			10-NOV-82	10-NOV-82
LITTON	DR R SALTER				CO	GLASER			10-NOV-82	10-NOV-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
M/A COM	K CARR		BURLINGTON	EA	CO	GLASER			10-NOV-82	10-NOV-82
MACDAC	DR S FURUKAWA		KSC	SO	LS	OLCOTT	RUDIGER		5-OCT-82	5-OCT-82
MANVILLE	F L PUNDSACK		DENVER	WE	MP	GRODZKA			10-NOV-82	
MBB-OTTO	H BASSNER		MUNICH	EU	I	HEKKING			9-DEC-82	9-DEC-82
MBB-OTTO	O A VONBREITENS		MUNICH	EU	I	HEKKING			9-DEC-82	9-DEC-82
MBB=OTTO	DR KLEINAU		MUNICH	EU	I	HEKKING			9-DEC-82	9-DEC-82
MCI	V O WRIGHT		WASH DC	EA	CO	GLASER			10-NOV-82	
MEAD	DR C SPALDING	513/222-6323	DAYTON	MW	MP	GRODZKA			14-OCT-82	14-OCT-82
MERCK	J L HUCK		RAHWAY,NJ	EA	MP	GRODZKA			10-NOV-82	
MET IND	L S LORMAN	201/542-5800	EATONTOWN,NJ	EA	CO	GRODZKA			21-OCT-82	
MET PROP	A O SCHAEFER	212/644-7693	NY,NY	EA	CO	GRODZKA			22-OCT-82	
MET PWDR	K H ROLL	609/452-7700	PRINCETON	EA	CO	GRODZKA			19-OCT-82 18-JAN-83	19-OCT-82 18-JAN-83
METROMED	J W KLUGE		SEACAUCUS NJ	EA	CO	GLASER			10-NOV-82	
MICOM	J WALKER	213/998-8844	CHATSWORTH	WE	CO	GLASER			26-JAN-83	26-JAN-83
MITCHELL	W K WHITE	713/363-5500	TEXAS	MW	CO	GRODZKA			30-NOV-82	
MOBIL	J J WISE	212/883-3133	NY,NY	EA	MP	GRODZKA			10-NOV-82 12-JAN-83	10-NOV-82 12-JAN-83
MONSANTO	R J MAHONEY		ST LOUIS	MW	MP	GRODZKA			10-NOV-82	
MONSANTO	DR T TOLBERT	314/694/5925	ST LOUIS	MW	CO	GRODZKA			22-NOV-82	22-NOV-82
MOTOROLA	J F MITCHELL		SCHAUMB IL	MW	MP	GRODZKA			10-NOV-82	
MPE GARC	DR J TREUMPER		MUNICH	EU	I	HEKKING			8-DEC-82	8-DEC-82
MPI GARC	REPPIN		MUNICH	EU	I	HEKKING			8-DEC-82	8-DEC-82
MPI GARC	DR TRUMPER		MUNICH	EU	I	HEKKING			8-DEC-82	8-DEC-82
MPI GARC	KLECKER		MUNICH	EU	I	HEKKING			8-DEC-82	8-DEC-82
MPI GARC	DR HARRENDEL		MUNICH	EU	I	VONDRAK VONDRAK			8-DEC-82 21-JAN-83	8-DEC-82 21-JAN-83
N A MFG	A B TROWBRIDGE	202/626-3700	WASH DC	EA	C	GLASER			10-NOV-82	

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	MEMBER-1	MEMBER-2	MEMBER-3	SCHED	ACTUAL
N Y TIME	A U ROSENTHAL		NY,NY	EA	CO	GLASER			10-NOV-82	
NASA	M DUKE	713/483-4464	JSC	SO	SA	STRAIGHT				
NASA	W PHINNEY	713/483-3816	JSC	SO	SA	STRAIGHT				
NASA	L PARKER	202/755-3872	HDQTR	EA		STRAIGHT			26-AUG-82	26-AUG-82
NASA	DR D B SMITH	202/755-3880	HDQTR	EA		STRAIGHT			26-AUG-82	26-AUG-82
NASA	P SMITH		HDQTR	EA		STRAIGHT			26-AUG-82	
NASA	D ROUSCH		HDQTR	EA		STRAIGHT			26-AUG-82	
NASA	J ERICKSON	202/755-3752	HDQTR	EA	SA	STRAIGHT			10-SEP-82	10-SEP-82
						STRAIGHT			20-SEP-82	20-SEP-82
						STRAIGHT			1-NOV-82	1-NOV-82
NASA	DR W PIOTROWSKI	202/755-6038	HDQTR	EA	SA	STRAIGHT			14-SEP-82	14-SEP-82
NASA	DR T HALSTEAD		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		15-SEP-82	15-SEP-82
NASA	DR P RAMBAUT		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		15-SEP-82	15-SEP-82
NASA	M SANDER		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		15-SEP-82	15-SEP-82
NASA	C YOST	202/755-3503	HDQTR	EA	SA	STRAIGHT			15-SEP-82	15-SEP-82
						GRODZKA			14-DEC-82	14-DEC-82
NASA	J WEBER	202/755-7450	HDQTR	EA	SA	STRAIGHT			15-SEP-82	15-SEP-82
NASA	O SMISTAD		HDQTR	EA	C	STRAIGHT			15-SEP-82	15-SEP-82
						STRAIGHT			27-OCT-82	27-OCT-82
NASA	DR E SCHMERLING	202/755-8573	HDQTR	EA	PS	VONDRAK			15-SEP-82	15-SEP-82
NASA	DR J T LYNCH		HDQTR	EA	PS	VONDRAK			15-SEP-82	15-SEP-82
NASA	DR D M BUTLER	202/755-8604	HDQTR	EA	PS	VONDRAK			15-SEP-82	15-SEP-82
						VONDRAK			29-SEP-82	29-SEP-82
NASA	DR G SOFFEN		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	B BISHOP		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	A NICOGOSSIAN		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	B CRAMER		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	J BREDT		HDQTR-OSSA	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
NASA	B SMITH		HDQTR-OSTS	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	D DE VINCENGI		HDQTRS-OSSA	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	R WHITTEN		HDQTRS-OSSA	EA	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	A BEHREND		JSC	SO	LS	OLCOTT	RUDIGER		16-SEP-82	16-SEP-82
NASA	M. KREUGER	202/755-3970	HDQTR	EA	M	STRAIGHT			16-SEP-82	16-SEP-82
						STRAIGHT			1-NOV-82	1-NOV-82
NASA	J SHAW	202/755-3970	HDQTR	EA	M	STRAIGHT			16-SEP-82	17-SEP-82
NASA	D NORTON	202/755-3890	HDQTR	EA		STRAIGHT			16-SEP-82	16-SEP-82
NASA	L WIGBELS	202/755-3880	HDQTR	EA		STRAIGHT			16-SEP-82	16-SEP-82
						STRAIGHT			15-OCT-82	15-OCT-82
NASA	J KOLTANBOCK	713/483-3611	JSC	SO	M	STRAIGHT			21-SEP-82	21-SEP-82
NASA	E GOMERSALL		AMES	WE	LS	OLCOTT	RUDIGER		24-SEP-82	24-SEP-82
NASA	DR P BUCHANAN		KSC	SO	LS	OLCOTT	RUDIGER		28-SEP-82	5-OCT-82
NASA	W KNOTT		KSC	SO	LS	OLCOTT			28-SEP-82	5-OCT-82
NASA	G SHARP		KSC	SO	LS	RUDIGER			28-SEP-82	
NASA	H P GIEROW		MSFC	SO	LS	OLCOTT	RUDIGER		29-SEP-82	6-OCT-82
NASA	C DESANCTIS		MSFC	SO	LS	OLCOTT	RUDIGER		29-SEP-82	6-OCT-82
NASA	R HUMPHRIES		MSFC	SO	LS	OLCOTT	RUDIGER		29-SEP-82	6-OCT-82
NASA	DR G P NEWTON	202/755/1265	HDQTR	EA	PS	VONDRAK			29-SEP-82	29-SEP-82
NASA	DR M CARD	804/827-3121	LARC	EA	T	FORSBERG	STEGMAN		30-SEP-82	30-SEP-82
NASA	C ELDRED		LA RC	EA	M	FORSBERG	STEGMAN		30-SEP-82	30-SEP-82
NASA	DR F ALLARIO	804/827-3601	LA RC	EA	M	FORSBERG	STEGMAN		30-SEP-82	30-SEP-82
						FORSBERG	STEGMAN		8-MAR-83	8-MAR-83
NASA	B DOVE		LA RC	EA	M	FORSBERG	STEGMAN		30-SEP-82	30-SEP-82
NASA	R HOOK		LA RC	EA	M	FORSBERG	STEGMAN		30-SEP-82	30-SEP-82
						FORSBERG	STEGMAN		8-MAR-83	8-MAR-83

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
NASA	L DIETLEIN		JSC	MW	LS	OLCOTT	RUDIGER		30-SEP-82	7-OCT-82
NASA	DR S POOL		JSC	MW	LS	OLCOTT	RUDIGER		30-SEP-82	7-OCT-82
NASA	P JOHNSON		JSC	MW	LS	OLCOTT	RUDIGER		30-SEP-82	7-OCT-82
NASA	C LEACH HUNTOON		JSC	MW	LS	OLCOTT	RUDIGER		30-SEP-82	7-OCT-82
NASA	B BUSH		JSC	MW	LS	OLCOTT	RUDIGER		30-SEP-82	8-OCT-82
NASA	S NACHTWEY		JSC	MW	LS	OLCOTT	RUDIGER		30-SEP-82	7-OCT-82
NASA	H GRANGER	713/483-5305	JSC	SO	LS	OLCOTT	RUDIGER		30-SEP-82	7-OCT-82
						STRAIGHT			1-NOV-82	1-NOV-82
						STRAIGHT			29-DEC-82	29-DEC-82
NASA	W GUY		JSC	MW	LS	OLCOTT	RUDIGER		1-OCT-82	8-OCT-82
NASA	F SAMONSKI		JSC	MW	LS	OLCOTT	RUDIGER		1-OCT-82	8-OCT-82
NASA	DR J SHARP		AMES	WE	LS	OLCOTT	RUDIGER		4-OCT-82	5-OCT-82
NASA	K SOUZA		AMES	WE	LS	OLCOTT	RUDIGER		4-OCT-82	1-NOV-82
NASA	DR I LONG		KSC	SO	LS	OLCOTT	RUDIGER		5-OCT-82	5-OCT-82
NASA	J STONESIFER		JSC	SO	LS	DONNENWO			6-OCT-82	6-OCT-82
NASA	DR J HILCHEY		MSFC	SO	LS	OLCOTT	RUDIGER		6-OCT-82	6-OCT-82
NASA	C RAY		MSFC	SO	LS	OLCOTT	RUDIGER		6-OCT-82	6-OCT-82
NASA	L POWELL		MSFC	SO	LS	OLCOTT	RUDIGER		6-OCT-82	6-OCT-82
						HEKKING			22-OCT-82	22-OCT-82
NASA	J MASON		JSC	SO	LS	OLCOTT	RUDIGER		7-OCT-82	7-OCT-82
NASA	J HOMICK		JSC	SO	LS	OLCOTT	RUDIGER		7-OCT-82	7-OCT-82
NASA	D MAYO		JSC	SO	LS	OLCOTT	RUDIGER		8-OCT-82	8-OCT-82
NASA	B MARSHALL		MSFC	SO		HEKKING			21-OCT-82	21-OCT-82
NASA	B NIXON		MSFC	SO		HEKKING			21-OCT-82	21-OCT-82
NASA	B HUBER		MSFC	SO		HEKKING			21-OCT-82	21-OCT-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	MEMBER-1	MEMBER-2	MEMBER-3	SCHED	ACTUAL
NASA	P CULBERTSON		HDQTR	EA		HEKKING			21-OCT-82	21-OCT-82
NASA	C DE SANTIS		MSFC	SO		HEKKING			22-OCT-82	22-OCT-82
NASA	R JOOSTEN	713/483-4763	JSC	SO	SA	STRAIGHT			25-OCT-82	25-OCT-82
NASA	R HILL	713/483-4763	JSC	SO	SA	STRAIGHT			25-OCT-82	27-OCT-82
NASA	K DEMEL	713/483-3611	JSC	SO	SA	STRAIGHT			27-OCT-82	25-OCT-82
NASA	W HUFFSTETLER	713/483-4447	JSC	SO	SA	STRAIGHT			30-OCT-82	30-OCT-82
NASA	DR R JOHNSON	415/965-5117	AMES	WE	LS	OLCOTT	RUDIGER		1-NOV-82	1-NOV-82
					MP	GRODZKA	RUDIGER		26-JAN-83	26-JAN-83
					MP	GRODZKA			28-JAN-83	28-JAN-83
NASA	R ARNO		AMES	WE	LS	OLCOTT	RUDIGER		1-NOV-82	1-NOV-82
NASA	B BERRY		AMES	WE	LS	OLCOTT	RUDIGER		1-NOV-82	1-NOV-82
NASA	H SANDLER		AMES	WE	LS	OLCOTT	RUDIGER		1-NOV-82	1-NOV-82
NASA	P QUATTRONE		AMES	WE	LS	OLCOTT	RUDIGER		1-NOV-82	1-NOV-82
NASA	DR D MORRISON		JSC	SO	MP	GRODZKA			1-DEC-82	1-DEC-82
NASA	R HARRIS		PARIS	EU	I	HEKKING			6-DEC-82	6-DEC-82
NASA	GN J ABRAHAMSON		WASH DC	EA		FORSBERG			14-DEC-82	14-DEC-82
NASA	H QUONG	202/755-3524	HDQTR	EA		FORSBERG			14-DEC-82	31-JAN-83
NASA	DR JW FREEMAN		GSFC	EA	SA	VONDRAK			21-JAN-83	21-JAN-83
NASA	J MOORE		HDQTR	EA	M	FORSBERG	HUNTER		16-FEB-83	16-FEB-83
NASA	R CARLISLE	202/755-2413	HDQTR	EA		FORSBERG	HUNTER		17-FEB-83	17-FEB-83
NASA	I BEKEY	202/755-2344	HDQR	EA		FORSBERG	HUNTER		17-FEB-83	17-FEB-83
NASA	R FREITAG	202/755/2333	HDQTR	EA		FORSBERG	HUNTER		17-FEB-83	17-FEB-83
NASA	J HODGE	202/755-2333	HDQTR	EA		FORSBERG	HUNTER	FISHER	18-FEB-83	18-FEB-83
NASA	J MULLINS		HDQTRS	EA	M	FORSBERG	STEGMAN	HAYES	9-MAR-83	9-MAR-83
NASA	J AMBRUSS		HDQTRS	EA		FORSBERG	STEGMAN		9-MAR-83	9-MAR-83
NASA	M NOLAN		HDQTRS	EA		FORSBERG	STEGMAN		9-MAR-83	9-MAR-83

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
NASA	S GORLAND		LERC	MW	T	D SMITH			17-MAR-83	17-MAR-83
NASA	R THOMAS		LERC	MW	T	D SMITH			17-MAR-83	17-MAR-83
NASA	I MEYERS		LERC	MW	T	D SMITH			17-MAR-83	17-MAR-83
NASA	C FAYMAN		LERC	MW	T	D SMITH			17-MAR-83	17-MAR-83
NASA	J COLLINS		LERC	MW	T	D SMITH			17-MAR-83	17-MAR-83
NASA	J MALLOY		LERC	MW	T	D SMITH			17-MAR-83	
NASA	H SCHWARTZ		LERC	MW	T	D SMITH			17-MAR-83	17-MAR-83
NASA	J HELLER		LERC	MW	T	D SMITH			17-MAR-83	17-MAR-83
NATL SEM	C E SPORK		SANTA CLARA	WE	MP	GRODZKA			10-NOV-82	
NBB-OTTO	DR HUSMAN		MUNICH	EU	I	HEKKING			9-DEC-82	9-DEC-82
NBC	R MULHOLLAND		NY,NY	EA	CO	GLASER			10-NOV-82	
NCR	DR T TANG	513/445-5000	DAYTON	MW	MP	GRODZKA			14-OCT-82	14-OCT-82
NE MED	F G STOUT			EA	MD	GLASER			10-NOV-82	10-NOV-82
NIVR	D DE HOOP		DELFT	EU	I	HEKKING			17-DEC-82	17-DEC-82
NO TELEC	E D FITZGERALD		NASHVILLE	EA	CO	GLASER			10-NOV-82	
NORTON	E GORSUCH			EA	CO	GLASER			10-NOV-82	10-NOV-82
NORTON	D R MELVILLE		WORCESTER	EA	MP	GRODZKA			10-NOV-82	
NSC	COL G RYE		WASH DC	EA	M	FORSBERG			15-DEC-82	15-DEC-82
OMB	J STRUTHERS		WASH DC	EA		FORSBERG			14-DEC-82	
ONERA	G COUPRY		PARIS	EU	I	FORSBERG			15-SEP-82	15-SEP-82
ONERA	COUPRY		PARIS	EU	I	HEKKING			7-DEC-82	7-DEC-82
ONERA	DORDAIN		PARIS	EU	I	HEKKING			7-DEC-82	7-DEC-82
OPIN RES	I MILLER				CO	GLASER			26-JAN-83	26-JAN-83
OWENS-CO	W W BOESCHENSTE		TOLEDO	MW	MP	GRODZKA			10-NOV-82	
OWENS-IL	W F SPENGLER		TOLEDO	MW	MP	GRODZKA			10-NOV-82	
PA LAUNC	G HUDSON				CO	FORSBERG			26-JAN-83	26-JAN-83

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
PENNZOIL	T HEMEYER	713/236-7524	HOUSTON	SO	MP	GRODZKA			28-OCT-82	28-OCT-82
PFIZER	G D LAUBACH		NY,NY	EA	MP	GRODZKA			10-NOV-82	
PHAR MFG	G SCHWARTZ	212/838-3720	NY,NY	EA	CO	GRODZKA			21-OCT-82	
PLAN GRP	E GRIGSBY				CO	GLASER			26-JAN-83	26-JAN-83
POLAROID	W J MCCUNE JR		CAMBRIDGE	EA	MP	GRODZKA			10-NOV-82	
PPG IND	J E BURRELL		PITTSBURGH	EA	MP	GRODZKA			10-NOV-82	
PR CHINA	CHONG WU		WASH	EA	SA	STRAIGHT			4-OCT-82	
RAYCHEM	B MCKINLEY		MENLO PARK	WE	CO	GRODZKA			26-JAN-83	26-JAN-83
RAYCHEM	DR TC CHENG	415/361-4019	MENLO PARK	WE	MP	GRODZKA			28-JAN-83	28-JAN-83
RCA	T F BRADSHAW		NY,NY	EA	MP	GRODZKA			10-NOV-82	
REVERE	W F COLLINS		NY,NY	EA	MP	GRODZKA			10-NOV-82	
REYNOLDS	J E BLOOMQUIST		RICHMOND	EA	MP	GRODZKA			10-NOV-82	
ROCKWELL	E G COLE		PITTSBURGH	EA	CO	GLASER			10-NOV-82	10-NOV-82
ROCKWELL	E ASH	213/647-5571	EL SEGUNDO	WE	CO	FORSBERG			26-JAN-83	26-JAN-83
SAI	P VALK				CO	GLASER			26-JAN-83	26-JAN-83
SCHERING	R P LUCIANO		KENILWORTH N	EA	MP	GRODZKA			10-NOV-82	
SCI	F J GAUDE				CO	GLASER			26-JAN-83	26-JAN-83
SCI ATL	S TOPOL		ATLANTA	SO	CO	GLASER			10-NOV-82	
SEARLE	DR A KLIMSTRA	312/982-7867	SKOKIE	MW	MP	GRODZKA			19-OCT-82	19-OCT-82
SHELL	K L MAI		HOUSTON	SO	MP	GRODZKA			10-NOV-82	
SMITH/CL	H WENDT		PHILADELPHIA	EA	MP	GRODZKA			10-NOV-82	
SO AFRIC	C HIDE	202/232-4400	WASH	EA	SA	STRAIGHT			4-OCT-82	26-OCT-82
						STRAIGHT			7-DEC-82	7-DEC-82
SO IND	SL NELSON			MW	CO	GLASER			26-JAN-83	26-JAN-83
SPA TRAN	K P HEISS				CO	GLASER			10-NOV-82	10-NOV-82
SPAR	B TAYLOR		ONTARIO	MW	I	BENE	FISHER	WALLER	6-DEC-82	6-DEC-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	MEMBER-1	MEMBER-2	MEMBER-3	VISITS SCHED	VISITS ACTUAL
SRI	J WILHELM		MENLO PARK	WE	CO	GLASER			26-JAN-83	26-JAN-83
STD OIL	R M MORROW		CHICAGO	MW	MP	GRODZKA			10-NOV-82	
STOR TEC	J A RODRIQUEZ	303/673-5151	LOUISVILLE,	MW	CO	GRODZKA			28-OCT-82	
SWEDEN	J STARFELT	202/298-3500	WASH	EA	SA	STRAIGHT			4-OCT-82	13-OCT-82
SWEDEN	L ERICSON		WASH	WA	SA	STRAIGHT			13-OCT-82	13-OCT-82
						STRAIGHT			7-DEC-82	7-DEC-82
SYNTEX	C MAHLER		PALO ALTO	WE	CO	GLASER			26-JAN-83	26-JAN-83
SYS DEV	R SALKELD	213/453-5153	TOPANGA CYD	WE	CO	GLASER			26-JAN-83	26-JAN-83
SYS RES	W E DIRKES	513/426-6050	DAYTON	MW	MP	GRODZKA			12-OCT-82	12-OCT-82
TAMCO	L R TOLLENOR	213/268-4111	MONT PARK, C	WE	CO	GRODZKA			29-OCT-82	
TANDY	P R NORTH	817/390-3700	FT WORTH	MW	CO	GRODZKA			29-NOV-82	
TELEDYNE	R NOBLITT	301/881-2090	ROCKVILLE MD	EA	CO	GRODZKA			26-JAN-83	26-JAN-83
TEPIAC	DR CH HO	317/494-6300	W. LAFAY IN	MW	MP	GRODZKA			20-OCT-82	20-OCT-82
TERRA MA	D WALKLET	415/964-6900	MT VIEW, CA	WE	CO	FORSBERG			26-JAN-83	26-JAN-83
TEXAS IN	J F BUCY		DALLAS	SO	MP	GRODZKA			10-NOV-82	
TPD	A HAMMERSCHLAG		DELFT	EU	I	HEKKING			17-DEC-82	17-DEC-82
TRANE	R J CAMPBELL		LACROSSE WI	MW	CO	GLASER			10-NOV-82	
TRAVENOL	DR J THOMAS		CHICAGO	MW	CO	GRODZKA			24-NOV-82	24-NOV-82
U TEXAS	DR J FABRICANT		GALVESTON	SO	LS	OLCOTT	RUDIGER		8-OCT-82	8-OCT-82
UCSD	DR J CARROLL		SAN DIEGO	WE	T	FORSBERG			28-FEB-83	28-FEB-83
						D SMITH	FORSBERG		21-MAR-83	21-MAR-83
UNION CA	W M ANDERSON		NY,NY	EA	MP	GRODZKA			10-NOV-82	
UNIV OIL	DR MARY GOOD	312/391-3331	DES PLAINS I	MW	CO	GRODZKA			23-NOV-82	23-NOV-82
UPJOHN	W W HUBBARD,JR		NEW BRUNS, N	EA	MP	GRODZKA			10-NOV-82	
US STEEL	W R ROESCH		PITTSBURGH	EA	MP	GRODZKA			10-NOV-82	
USA	CAPT C YUKNIS	202/697-5575	PENTAGON	EA	M	FORSBERG	STEGMAN		16-SEP-82	16-SEP-82
						FORSBERG			26-OCT-82	26-OCT-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
USA	COL R A SCHOW	703/274-8342	ALEXANDRIA	EA	M	FORSBERG	STEGMAN	HUNTER	17-SEP-82	17-SEP-82
USA	W J MORAN	703/274-8342	ALEXANDRIA	EA	M	FORSBERG	STEGMAN	HUNTER	17-SEP-82	17-SEP-82
USA	MAJ G BREWER	202/695-5509	PENTAGON	EA	M	FORSBERG	STEGMAN		17-SEP-82	17-SEP-82
USA	LC H M TUTTLE		PENTAGON	EA	M	FORSBERG	STEGMAN		17-SEP-82	17-SEP-82
USA	J VAN SANT		FT MONROE	EA	M	FORSBERG	STEGMAN		30-SEP-82	1-OCT-82
USA	P O'KEEFE	804/727-3441	FT MONROE	EA	M	FORSBERG	STEGMAN		1-OCT-82	1-OCT-82
USA	MAJ J GRUBBS	202/697-6526	PENTAGON	EA	M	STEGMAN	P. SMITH		26-OCT-82	26-OCT-82
USA	LCOL A LEWIS	202/694-8562	PENTAGON	EA	M	STEGMAN	P. SMITH		26-OCT-82	26-OCT-82
USA	COL RJ BROWNE		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USAF	LC R RUSSELL		LOS ANGELES	WE	M	FORSBERG				
USAF	MAJ M SPENCE		PENTAGON	EA	M	FORSBERG				
USAF	K MURPHY		ANDREWS AFB	EA	M	FORSBERG				
USAF	LC W WALKER	213/643-2312	LOS ANGELES	WE	M	FORSBERG				
USAF	MG R BOVERIE		WASH DC	EA	M	FORSBERG				
USAF	MAJ E SUNNBERG	213/416-7825	LOS ANGELES	WE	M	FORSBERG				
USAF	LCOL G CHESNEY		PENTAGON	EA	M	FORSBERG				
USAF	LCOL K PEYTON		ANDREWS AFB	EA	M	FORSBERG				
USAF	COL T MORRMAN		PETERSON AFB	WE	M	FORSBERG				
USAF	CO D RICHARDSON		LOS ANGELES	WE	LS	OLCOTT				
USAF	LCOL J B GROSS	202/695-7193	PENTAGON	EA	M	FORSBERG	STEGMAN	HUNTER	13-SEP-82	13-SEP-82
						FORSBERG	P. SMITH		15-OCT-82	15-OCT-82
						FORSBERG			15-DEC-82	15-DEC-82
USAF	COL J P FOSTER	202/697-6827	PENTAGON	EA	M	FORSBERG	STEGMAN		16-SEP-82	16-SEP-82
						FORSBERG	P. SMITH		14-OCT-82	14-OCT-82
						FORSBERG	STEGMAN	P. SMITH	26-OCT-82	26-OCT-82
USAF	MAJ T W SHORE	202/697-6827	WASH DC	EA	M	FORSBERG	STEGMAN		16-SEP-82	16-SEP-82
						FORSBERG	STEGMAN	P.SMITH	14-OCT-82	14-OCT-82
						FORSBERG			14-DEC-82	14-DEC-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	*********-CONTACT TEAM-********* MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-****** SCHED	ACTUAL
USAF	MAJ R ZWIRNBAUM		LOS ANGELES	WE	M	FORSBERG			23-SEP-82	8-OCT-82
USAF	MAJ L GAROZZO		PETERSON AFB	MW	M	FORSBERG	STEGMAN		27-SEP-82	27-SEP-82
						FORSBERG	P. SMITH	HUNTER	10-MAR-83	10-MAR-83
USAF	MAJ H RAINEY	402/294-5157	OFFUTT AFB	MW	M	FORSBERG	STEGMAN		28-SEP-82	28-SEP-82
						STEGMAN	P. SMITH	HUNTER	29-OCT-82	29-OCT-82
USAF	LC J E ANGELL	202/697-0649	PENTAGON	EA	M	FORSBERG	STEGMAN		29-SEP-82	29-SEP-82
						FORSBERG	STEGMAN		27-OCT-82	27-OCT-82
						FORSBERG	HUNTER		17-NOV-82	17-NOV-82
						FORSBERG	HUNGER		18-FEB-83	18-FEB-83
USAF	MAJ C. SCHADE		WASH DC	EA	M	FORSBERG			29-SEP-82	29-SEP-82
						FORSBERG			15-DEC-82	15-DEC-82
						FORSBERG	HUNTER		18-FEB-83	18-FEB-83
						FORSBERG	HUNTER	STEGMAN	9-MAR-83	9-MAR-83
USAF	LC T SHERMAN	804/764-9990	LANGLEY AFB	EA	M	FORSBERG	STEGMAN		30-SEP-82	30-SEP-82
USAF	GEN ORD		SAN ANTON	SO	LS	LS OLCOTT	RUDIGER		1-OCT-82	2-FEB-83
USAF	C ALEXANDER		SAN ANTONIO	SO	LS	RUDIGER			1-OCT-82	
USAF	MAJ S ROSEN		LOS ANGELES	WE	M	FORSBERG	P. SMITH	WOHL	7-OCT-82	7-OCT-82
USAF	COL F WISELY		LOS ANGELES	WE	M	FORSBERG	P. SMITH	FISHER	8-OCT-82	8-OCT-82
USAF	DR C COOK	202/695-2317	PENTAGON	EA	M	FORSBERG	STEGMAN		16-OCT-82	16-OCT-82
						FORSBERG	STEGMAN	P. SMITH	26-OCT-82	26-OCT-82
						FORSBERG			14-DEC-82	14-DEC-82
						FORSBERG	HUNTER		18-FEB-83	18-FEB-83
USAF	MAJ D NEWBERN	301/981-3267	ANDREWS AFB	EA	M	FORSBERG	STEGMAN	P. SMITH	26-OCT-82	26-OCT-82
USAF	LC V WEBB		ANDREWS AFB	EA	M	FORSBERG	STEGMAN	P. SMITH	26-OCT-82	26-OCT-82
USAF	CAPT S PERENIK	213/643-2440	LOS ANGELES	WE	M	D. SMITH			27-OCT-82	27-OCT-82
USAF	MAJ B LUNA	202/697-5890	PENTAGON	EA	M	FORSBERG	HUNTER		27-OCT-82	27-OCT-82
USAF	COL C HEIMACH	202/695-0547	PENTAGON	EA	M	P. SMITH	HUNTER		27-OCT-82	27-OCT-82
USAF	COL J HEILMAN	402/294-5157	OFFUT AFB	MW	LS	STEGMAN	P. SMITH	HUNTER	29-OCT-82	29-OCT-82
USAF	BG R EAGLET		ANDREWS AFB	EA	M	FORSBERG			18-NOV-82	18-NOV-82
USAF	COL G CUDD		OFFUTT AFB	MW	M	FORSBERG	STEGMAN	HUNTER	8-DEC-82	
USAF	COL E ROBERT		OFFUTT AFB	MW	M	FORSBERG	STEGMAN	HUNTER	8-DEC-82	
USAF	COL R NANNING		OFFUTT AFB	MW	M	FORSBERG	STEGMAN	HUNTER	8-DEC-82	

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	********-CONTACT TEAM-******** MEMBER-1	MEMBER-2	MEMBER-3	*****-VISITS-***** SCHED	ACTUAL
USAF	LC A HANKS		OFFUTT AFB	MW	M	FORSBERG	STEGMAN	HUNTER	8-DEC-82	
USAF	LC W RASMUSSON		OFFUTT AFB	MW	M	FORSBERG	STEGMAN	HUNTER	8-DEC-82	
USAF	COL R SAMAY		OFFUTT AFB	MW	M	FORSBERG	STEGMAN	HUNTER	8-DEC-82	
USAF	LC A GRAHAM		OFFUTT AFB	MW	M	STEGMAN	STEGMA	HUNTER	8-DEC-82	
USAF	DR B WELCH		SAN ANTON	SO	LS	OLCOTT	RUDIGER		2-FEB-83	2-FEB-83
USAF	COL D CARTER		SAN ANTON	SO	LS	OLCOTT	RUDIGER		2-FEB-83	2-FEB-83
USAF	COL D BEATTY		SAN ANTON	SO	LS	OLCOTT	RUDIGER		2-FEB-83	2-FEB-83
USAF	COL J WOLCOTT		SAN ANTON	SO	LS	OLCOTT	RUDIGER		2-FEB-83	2-FEB-83
USAF	LC B HARVEY		SAN ANTON	SO	LS	OLCOTT	RUDIGER		2-FEB-83	2-FEB-83
USAF	DR W MATOUSH		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USAF	LC L WHITE		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USAF	LC A SULKIN		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USAF	LC R VERCRUYSE		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USAF	COL E ROSS		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USAF	COL J HEILMAN		PETERSON AFB	MW	M	FORSBERG	P SMITH	HUNTER	10-MAR-83	10-MAR-83
USAL	LC V WEBB		LOS ANGELES	WE	M	FORSBERG	P. SMITH		8-OCT-82	8-OCT-82
USCG	CAPT W HYDE		WASH	EA	M	STRAIGHT			15-OCT-82	15-OCT-82
USDA	R HATCH	713/483-4017	HOUSTON	SO	SA	STRAIGHT			6-OCT-82	6-OCT-82
USDA/FAS	J MURPHY	202/447-5404	WASH	EA	SA	STRAIGHT				
USFS	P WEBER	713/483-2081	HOUSTON	SO	SA	STRAIGHT				
USFS	R ALLISON	202/235-2137	RESTON	EA	SA	STRAIGHT				
USN	RA L KOLLMORGEN		WASH DC	EA	M	FORSBERG				
USN		202/692-2182	WASH DC	EA	M	FORSBERG	STEGMAN	HUNTER	13-SEP-82	13-SEP-82
USN	CDR D HONHART	202/254-4562	WASH DC	EA	M	FORSBERG	STEGMAN	HUNTER	13-SEP-82	13-SEP-82
						FORSBERG	P. SMITH		14-OCT-82	14-OCT-82
						FORSBERG	STEGMAN	P. SMITH	27-OCT-82	27-OCT-82
USN	CAPT W B PEIRCE	202/697-8342	PENTAGON	EA	M	FORSBERG	STEGMAN		17-SEP-82	17-SEP-82
						FORSBERG	P. SMITH		15-OCT-82	15-OCT-82
						FORSBERG			14-DEC-82	14-DEC-82

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AGENCY/ COMPANY	USERNAME	PHONE	LOCATION/ CITY	REG	CD	MEMBER-1	MEMBER-2	MEMBER-3	SCHED	ACTUAL
USN	RADM W RAMSEY		WASH DC	EA	M	FORSBERG	STEGMAN		17-SEP-82	17-SEP-82
USN	CMDR D DIAZ	202/697-8342	PENTAGON	EA	M	FORSBERG	STEGMAN		17-SEP-82	17-SEP-82
						FORSBERG	P. SMITH		15-OCT-82	15-OCT-82
						FORSBERG			14-DEC-82	14-DEC-82
						FORSBERG	HUNTER		17-FEB-83	17-FEB-83
USN	DR R STEVENSON		SAN DIEGO	WE	M	FORSBERG	STEGMAN	P. SMITH	23-SEP-82	23-SEP-82
						FORSBERG	STEGMAN		22-SEP-82	22-SEP-82
USN	CDR B HOLLINGER	202/697-2187		EA	M	FORSBERG	STEGMAN		29-SEP-82	29-SEP-82
						STEGMAN			28-OCT-82	28-OCT-82
USN	CDR J JENSEN	202/697-0582	PENTAGON	EA	M	FORSBERG	P. SMITH		26-OCT-82	26-OCT-82
USN	RADM J MOONEY	202/254-4318	WASH DC	EA	M	FORSBERG	STEGMAN	P. SMITH	27-OCT-82	27-OCT-82
USN	G. JOINER	202/696-4202	ARLINGTON,VA	EA	M	STEGMAN	P. SMITH		27-OCT-82	27-OCT-82
USN	DR. FW DIETRICH	202/692-2182	WASH DC	EA	M	FORSBERG	STEGMAN	HUNTER	16-NOV-82	13-SEP-82
						FORSBERG	P.SMITH		16-NOV-82	16-NOV-82
USN	RADM J BUTTS		WASH DC	EA	M	FORSBERG			17-NOV-82	
USN	CAPT P EDSEN		WASH DC	EA	M	FORSBERG			17-NOV-82	
USN	CAPT AE ROWE		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USN	CDR J WADE		PETERSON AFB	MW	M	FORSBERG	P.SMITH	HUNTER	10-MAR-83	10-MAR-83
USRA	DR W D CUMMINGS	202/547-2609	COLUMBIA,MD	EA	PS	VONDRAK			29-SEP-82	29-SEP-82
UTC	DR R HERMANN		HARTFORD	EA	CO	GLASER			10-NOV-82	10-NOV-82
UTC	H J GRAY		HARTFORD	EA	MP	GRODZKA			10-NOV-82	
VARIAN	T D SEGE		PALO ALTO	WE	MP	GRODZKA			10-NOV-82	
VOUGHT	DR FW FENTER	214/266-2166	DALLAS	SO	MP	GRODZKA			25-OCT-82	25-OCT-82
WANG LAB	R CRUSIUS	617/459-5000	LOWELL,MA	EA	CO	GRODZKA			9-NOV-82	
WARNER-L	J D WILLIAMS		MOR PLAINS	EA	MP	GRODZKA			10-NOV-82	
WESTING	D D DANFORTH		PITTSBURGH	EA	MP	GRODZKA			10-NOV-82	
WHITTAK	J KLEIMAN	213/475-9411	LOS ANGELES	WE	CO	GRODZKA			29-OCT-82	
XEROX	D T KEARNS		STAMFORD	EA	MP	GRODZKA			10-NOV-82	
YARWAY	T B PALMER III		BLUE BELL PA	EA	CO	GLASER			10-NOV-82	

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SPACE STATION PROGRAMS

ATTACHMENT 2
SUPPORTING DATA AND ANALYSIS REPORTS
VOLUME I

DATA BASE

Lockheed

DATA BASE

The primary sources of specific user needs were NASA lists of planned missions. This data base was used because it is a prioritized identification of scientific missions for the next two decades. The only serious limitation to the candidate mission list is that it is now constrained by Shuttle/Spacelab capabilities. Therefore, the candidate mission list was supplemented with advanced concepts that have requirements that exceed Space Shuttle capability.

The user requirements for 245 science and applications missions were entered into the ARTS (Automated Requirements Traceability System) data system at Lockheed. Characteristic user needs are described in the printout.

The ARTS data base consists of 245 space missions taken primarily from NASA documents (e.g. OAST/NASA Space Systems Technology Model, NASW-2937, NASA Headquarters, September 1981; Science and Applications Space Platform: Payload accomodations study, SP82-MSFC-2583, NASA/Marshall Space Flight Center, March, 1982).

Ninety of the space missions used to get potential Space Station users to elaborate on their needs and requirements are included. It was not the intent of this contract to estimate or fill in missing mission data. Thus many of the missions are not totally complete in their detailed requirements.

A brief description of ARTS is included, followed by an alphabetical listing of the missions. The missions are ordered by their ID number.

ARTS OBJECTIVES AND CONFIGURATION

ARTS is a bookeeping program that operates on a data base consisting of the requirements for a target system and attributes related to each requirement.

It was the ARTS program that was used to compile the space station data base.

The major function of ARTS is to provide rapid and accurate traceability, upward and downward, in a requirements hierarchy or tree.

ARTS is hosted of LMSC on the UNIVAC 1110 and DEC VAX - 11/780 computers. The software currently consists of approximately 6200 lines of executable FORTRAN IV code. Of this, about 3500 lines are from the Regional Information Management System (RIMS) data base manager. RIMS is a relational data base manager written by Lockheed Engineering and Management Services Company for NASA - Johnson Space Center; with NASA permission, LMSC uses RIMS in ARTS and in other applications.

DATA FLOW AND INPUT

Inputs consist of requirements data (text and attributes); formats for data storage, for batch input and upadate, and for outputs; and commands to both the computer operating system and the ARTS software. ARTS stores the requirements data according to the specified formats, retrieves data from the files, performs manipulations on it as specified by the commands, and formats it for output. Output consists of a variety of reports routed to the computer terminal, line printer, or special devices.

Either realtime inputs or batch data can be entered at the computer terminal and edited using the system editor. Batch data also can be input in three other ways: from cards, from tape, or by direct transfer form a word processor using special hardware.

Control of processing is exercised by means of commands. Commands, like data, may be entered at a terminal or via a batch runstream; they consist of two-character mnemonics specifying the desired operation, followed by any other required control information.

DEVELOPMENT HISTORY

ARTS has been in limited use since June 1980 and in full operation since October 1980. ARTS initially was used by two unclassified proposal efforts, NOSS and Solar Electric Propulsion stage (SEPS). There are approximately 12 projects currently using ARTS, most of them early in full-scale development.

LMSC SPACE STATION DATA BASE INPUT

REQID	MISSION/EXPERIMENT	FAMILY	DERIVATION
SA2120	100-METER THINNED APERATURE TELESCOPE	PS/PH	
SA2590	ACTIVE CAVITY RADIOMETER (ACR)	PS/PH/I	SA1310
SA1150	ACTIVE MAGNETOSPHERIC PARTICLE TRACER EXPERIMENT	PS/PH	
SO1000	ADVANCED EARTH-OBSERVATION SPACECRAFT	PS/RO/GE	
SA1530	ADVANCED LAND OBSERVING SYSTEM (ALOS)	PS/RO	
SA2890	ADVANCED LIMB SCANNER (ALS)	PS/GE/PH/I	SA1310
SA2630	ADVANCED MICROWAVE SOUNDING UNIT (AMSU)	PS/GE/I	SA2490
SA2640	ADVANCED MOISTURE AND TEMPERATURE SOUNDER (AMTS)	PS/GE/I	SA2490
SA1240	ADVANCED X-RAY ASTROPHYSICS FACILITY	PS/PH	
SA2700	ATMOSPERIC PHOTOMETRIC IMAGING (AEPI)	PS/GE/I	SA2510/SA1310
SA2820	ATMOSPHERIC TRACE MOLECULES OBSERVED BY SPECTROSCOPY (ATMOS)	PS/GE/PH/I	SA1310
SA2870	ATMOSPHERIC X-RAY EMISSION TELESCOPE (AXET)	PS/GE/PH/I	SA1310
SA1110	CHEMICAL RELEASE MODULE FACILITY	PS/PH	
SA2110	COHERENT OPTICAL SYSTEM OF MODULAR IMAGING COLLECTOR (COSMIC)	PS/PH	
SA2660	COLOR SCANNER	PS/GE/I	SA2500/SA2610
SA1140	COSMIC BACKGROUND EXPLORER (COBE)	PS/PH	
SA1300	COSMIC RAY OBSERVATORY	PS/PH	
SA2730	CRYOGENIC LIMB ARRAY ETALON SPECTROMETER (CLAES)	PS/GE/PH/I	SA2520
SA1610	EARTH RADIATION BUDGET SATELLITE	PS/GE	
SA2570	ELECTROPHORESIS OPERATIONS IN SPACE (EOS)	SO/SE	
SA2830	ERBE --- W-MFOV	PS/GE/PH/I	SA1310/SA1610
SA2840	ERBE ---- SCANNER INSTRUMENT	PS/GE/PH/I	SA1310/SA1610
SA1170	EXTREME ULTRAVIOLET EXPLORER	PS/PH	
SA1160	GAMMA RAY OBSERVATORY (GRO)	PS/PH	
SA2190	GAMMA-RAY TRANSIENT EXPLORER (GTE)	PS/PH	
SA1590	GEOSTATIONARY OPERATIONAL ENVIRONMENT SATELLITE (GOES D,E,F)	PS/GE	
SA1210	GRAVITY PROBE-B	PS/PH	
SA1500	GRAVSAT A	PS/RO	
SA2740	HALOGEN OCCULTATION EXPERIMENT (HALEO)	PS/GE/PH/I	SA2520
SA2750	HIGH RESOLUTION DOPPLER IMAGER (HRDI)	PS/GE/PH/I	SA2520/SA1310
SA2560	IMAGING SPECTROMETER (IS) PAYLOAD	SO/GE	
SA2880	IMAGING SPECTROMETRIC OBSERVATORY (ISO)	PS/GE/PH/I	SA1310
SA2760	IMPROVED STRATOSPHERIC & MESOSPHERIC SOUNDER (ISAMS)	PS/GE/PH/I	SA2520
SA1090	INFRARED ASTRONOMICAL SATELLITE (IRAS)	PS/PH	
SA2090	INFRARED INTERFEROMETER	PS/PH	
SA1480	LANDSAT D-D'	PS/RO	
SA1320	LARGE AMBIENT DEPLOYABLE IR TELESCOPE	PS/PH	
SA1350	LARGE AREA MODULAR ARRAY X-RAY TELESCOPE	PS/PH	
SA2470	LIFE SCIENCES PAYLOAD #1 (LS-1)	LS	
SA2480	LIFE SCIENCES PAYLOAD #2 (LS-2)	LS	
SA2860	LIGHT DETECTION AND RANGING FACILITY (LIDAR)	PS/GE/PH/I	SA1310
SA1670	LOWER ATMOSPHERIC RESEARCH SATELLITE (LARS)	PS/GE	
SA2810	LYMAN-ALPHA WHITE LIGHT CORONOGRAPH (WLC)	PS/GE/PH/I	SA1310
SA2850	MAGNETOSPHERIC MULTIPROBES (MMP)	PS/GE/PH/I	SA1310
SA2580	MATERIALS EXPERIMENT ASSEMBLY (MEA)	SO/SE	
SA2490	METEOROLOGY PAYLOAD	PS/GE	
SA2770	MICROWAVE LIMB SOUNDER (MLS)	PS/GE/PH/I	SA2520
SA2650	MICROWAVE PRESSURE SOUNDER (MPS)	PS/GE/I	SA2490
SA2670	MICROWAVE RADIOMETER	PS/GE/I	SA2500/SA2610
SA1730	MULTI-SERVICE THIN ROUTE NARROWBAND PROGRAM	SO/COM	
SA1750	MULTIMISSION MODULAR SPACECRAFT	SO/ST	
SA1620	NOAA AG/TIROS-N	PS/GE	
SA1640	OCEAN CIRCULATION MISSION-TOPOGRAPHY EXPERIMENT (TOPEX)	PS/GE	
SA2680	OCEAN MICROWAVE PACKAGE	PS/GE/I	SA2500/SA2610

LMSC SPACE STATION DATA BASE INPUT

REQID	MISSION/EXPERIMENT	FAMILY	DERIVATION
SA2500	OCEAN PAYLOAD	PS/GE	
SA2610	OCEANOGRAPHIC OBSERVATORY	PS/GE	
SA2080	ORBITING INFRARED SUBMILLIMETER TELESCOPE (OIST)	PS/PH	
SA1830	POWER UTILIZATION PLATFORM - ALPHA(PUP-a)	SO/SE	
SA1860	POWER UTILIZATION PLATFORM - BETA(PUP-b)	SO/SE	
SA1840	SATELLITE SERVICES REMOTE FROM ORBITER	SO/SE	
SA2690	SCATTEROMETER	PS/GE/I	SA2500/SA2610
SA1700	SEARCH AND RESCUE MISSION	SO/COM	
SA1220	SHUTTLE INFRARED TELESCOPE FACILITY (SIRTF)	PS/PH	
SA2180	SOFT X-RAY EXPLORER	PS/PH	
SA2800	SOFT X-RAY TELESCOPE (SX)	PS/GE/PH/I	SA1310
SA2600	SOLAR (UV) SPECTRAL IRRADIANCE MONITOR (SUSIM)	PS/PH/I	SA1310/SA2520
SA1200	SOLAR CORONA EXPLORER (SCE)	PS/PH	
SA1280	SOLAR INTERIOR DYNAMICS MISSION (SIDM)	PS/PH	
SA1600	SOLAR MESOSPHERE EXPLORER (SME)	PS/GE	
SA1130	SOLAR OPTICAL TELESCOPE (SOT)	PS/PH	
SA1250	SOLAR SOFT X-RAY TELESCOPE FACILITY	PS/PH	
SA1310	SOLAR TERRESTRIAL OBSERVATORY (STO)	PS/PH/GE	
SA2710	SPACE EXPERIMENTS WITH PARTICLE ACCELATORS (SEPAC)	PS/GE/I	SA2510/SA1310
SA1370	SPACE LAB BIOLOGICAL AND MEDICAL EXPERIMENT	LS	
SA2510	SPACE PLASMA PHYSICS (SPP) PAYLOAD	PS/GE	
SA1470	SPACE SCIENCE PLATFORM	LS	
SA1850	SPACE STATION	SO/SE	
SA1100	SPACE TELESCOPE	PS/PH	
SA1790	SPACELAB	SO/SE	
SA1230	STARLAB	PS/PH	
SA2620	SYNTHETIC APERATURE RADAR (SAR)	PS/GE	
SA2780	TEMP AND WIND MEASUREMENTS IN THE MESOSPHERE & LOWER THERMOSPHERE (TWM)	PS/GE/PH/I	SA2520
SA2790	ULTRAVIOLET SOLAR SPECTRAL IRRADIANCE EX (USSIE)	PS/PH/I	SA2520
SA2520	UPPER ATMOSPHERE RESEARCH SATELLITE (UARS)	PS/GE/PH	
SA1630	UPPER ATMOSPHERIC RESEARCH SATELLITES (UARS)	PS/GE	
SA2140	VERY LARGE SPACE TELESCOPE (VLST)	PS/PH	
SA2130	VERY LONG BASELINE UV/OPTICAL/IR INTERFEROMERTER	PS/PH	
SA2720	WAVES IN SPACE PLASMAS (WISP)	PS/GE/I	SA2510/SA1310
SA1340	X-RAY OBSERVATORY	PS/PH	
SA1180	X-RAY TIMING EXPLORER (XTE)	PS/PH	

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REQID	S01000
SOURCE	LSST VOL 1, 11-81
CONTACT/AUTHOR	A.L. BROOK, MARTIN MARIETTA
DERIVATION	
FAMILY	PS/RO/GE
MISSION/EXPERIMENT	ADVANCED EARTH-OBSERVATION SPACECRAFT
ALTITUDE	700 (KM)
INCLINATION	60-98 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	
WEIGHT/MASS	03584 (KG)
AVERAGE POWER	00.5 (KW)
PEAK POWER	02.6 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	S01000.TXT

Earth Surface, Atmosphere, and Ocean wavelength - Ultraviolet to Infared.

REQID	SA1090
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	INFRARED ASTRONOMICAL SATELLITE (IRAS)
ALTITUDE	900 (KM)
INCLINATION	90 DEG
ORBIT	POLAR
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	1980
SIZE	3.6 X 1.6 dia (M)
WEIGHT/MASS	01019 (KG)
AVERAGE POWER	00.2 (KW)
PEAK POWER	00.364 (KW)
DATA (I/O RATES)	0008.0-1048.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	0030.9 (ARC SEC)
MANNING	
INTERFACES	STDN
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1090.TXT

The Infrared Astronomical Satellite is to produce an unbiased all sky survey in the wavelenths between 8 and 120 um.

REQID	SA1100
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	SPACE TELESCOPE
ALTITUDE	600 (KM)
INCLINATION	28.8 (DEG)
ORBIT	
MISSION DURATION	180 MONTHS
TECHNOLOGY DATE	1980
SIZE	13.6 X 4.3 dia (M)
WEIGHT/MASS	11070 (KG)
AVERAGE POWER	02.1 (KW)
PEAK POWER	02.367 (KW)
DATA (I/O RATES)	0004.0-1024.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0000.01 (ARC SEC)
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	STDN, TDRSS
SERVICE/MAINT	2.5 YEARS/5 YEAR REFURBISHMENT
LOGISTICS	2.5 YEARS
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	1300 (KG)
TEXT	SA1100.TXT

The Space Telescope is a large light-gathering instrument with optical performance near the diffration limit.

REQID	SA1110
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	CHEMICAL RELEASE MODULE FACILITY
ALTITUDE	250 TO 1200 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	072 MONTHS
TECHNOLOGY DATE	1980
SIZE	2 X 3 dia (M)
WEIGHT/MASS	02700 (KG)
AVERAGE POWER	00.02 (KW)
PEAK POWER	00.18 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1110.TXT

The Chemical Release Module Facility will have the capability of multiple releases of chemicals into the magnetosphere/ionosphere system.

REQID	SA1130
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	SOLAR OPTICAL TELESCOPE (SOT)
ALTITUDE	460 (KM)
INCLINATION	33-57 DEG
ORBIT	
MISSION DURATION	000.2 - 000.7 MONTHS
TECHNOLOGY DATE	1980 (1987 LAUNCH)
SIZE	7.3 X 3.9 dia (M)
WEIGHT/MASS	08175 (KG)
AVERAGE POWER	00.935 (KW)
PEAK POWER	
DATA (I/O RATES)	5000.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0000.1 (ARC SEC)
POINTING ACC	0018.0 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	6 MONTH REVISIT
LOGISTICS	
THERMAL/CNTRL COND	4-6 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1130.TXT

Solar Optical Telescope (SOT) will obtain high resolution data which is required to solve fundamental problems in solar physics. Avoid standard optical system contaminats. SOT pointing repeatability 2.0 (arc sec)-1 orbit, 5.0 (arc sec) between sucessive orbits.

REQID	SA1140
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	COSMIC BACKGROUND EXPLORER (COBE)
ALTITUDE	900 (KM)
INCLINATION	99 DEG
ORBIT	
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	1982
SIZE	
WEIGHT/MASS	01421 (KG)
AVERAGE POWER	00.385 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1140.TXT

Cosmic Background Explorer (COBE) will measure the diffuse infrared and microwave emission of the universe.

REQID	SA1150
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	ACTIVE MAGNETOSPHERIC PARTICLE TRACER EXPERIMENT
ALTITUDE	300 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	1981
SIZE	1.1 X 3.0 dia (M)
WEIGHT/MASS	00670 (KG)
AVERAGE POWER	00.12 (KW)
PEAK POWER	
DATA (I/O RATES)	0001.0-0120.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	DSN
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1150.TXT

The Active Magnetospheric Particle Tracer Experiment (AMPTE) is designed to study the question of access of solar wind ions to the magnetosphere, the convective-diffusive transport and energization of magnetosoheric particles, and the elemental and charge composition of magnetospheric ions.

REQID	SA1160
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	GAMMA RAY OBSERVATORY (GRO)
ALTITUDE	400 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	1981
SIZE	6 X 4.5 dia (M)
WEIGHT/MASS	11000 (KG)
AVERAGE POWER	02.0 (KW)
PEAK POWER	
DATA (I/O RATES)	0032.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1160.TXT

Gamma Ray Observatory (GRO) will study the most energetic photons originating in our galaxy and beyond.

REQID	SA1170
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	EXTREME ULTRAVIOLET EXPLORER
ALTITUDE	550 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	1982
SIZE	4.5 CUBIC METERS
WEIGHT/MASS	00400 (KG)
AVERAGE POWER	00.07 (KW)
PEAK POWER	00.11 (KW)
DATA (I/O RATES)	0032.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1170.TXT

Extreme Ultraviolet Explorer objectives are to discover, obtain accurate positions, and determine the spectral energy distribution for all detectable EUV sources in the solar neighborhood.

REQID	SA1180
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	X-RAY TIMING EXPLORER (XTE)
ALTITUDE	400 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	1983
SIZE	2 X 2 X 4 (M)
WEIGHT/MASS	01000 (KG)
AVERAGE POWER	00.6 (KW)
PEAK POWER	01.5 (KW)
DATA (I/O RATES)	0064.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0004.1 (ARC SEC)
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1180.TXT

The X-RAY Timing Explorer will be devoted to the study of temporal variability in x-ray emitting objects.

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REQID	SA1200
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	R. CHAPMAN, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	SOLAR CORONA EXPLORER (SCE)
ALTITUDE	600 (KM)
INCLINATION	33 DEG
ORBIT	
MISSION DURATION	036 MONTHS
TECHNOLOGY DATE	1983
SIZE	
WEIGHT/MASS	00400 (KG)
AVERAGE POWER	00.3 (KW)
PEAK POWER	
DATA (I/O RATES)	5000.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0002.0 (ARC SEC)
POINTING ACC	0010.3 (ARC SEC)
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1200.TXT

The Solar Corona Explorer will investigate the structure, dynamics, and evolution of the corona, in order to study, globally and in the required physical detail, the close coupling between the inner corona and the heliosphere.

REQID	SA1210
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	R.A. POTTER, MSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	GRAVITY PROBE-B
ALTITUDE	500-600 (KM)
INCLINATION	
ORBIT	POLAR ORBIT
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	1983
SIZE	4.2 X 4.2 dia (M)
WEIGHT/MASS	01530 (KG)
AVERAGE POWER	00.22 (KW)
PEAK POWER	00.27 (KW)
DATA (I/O RATES)	0001.0 (KBPS)
DATA (STORAGE CAP)	00000.5 (MBITS)
STABILITY	0000.02 (ARC SEC)
POINTING ACC	0000.001 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1210.TXT

The Gravity Probe-B mission will measure the geodetic precision due to the motion of a gyroscope through a gravitational field (relativistic spin-orbit coupling) and the precision produced by the twisting of space due to the rotation of the Earth itself (relativistic spin-spin coupling).

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REQID	SA1220
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	L. YOUNG, ARC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	SHUTTLE INFRARED TELESCOPE FACILITY (SIRTF)
ALTITUDE	350-430 (KM)
INCLINATION	28.5 - 57 DEG
ORBIT	
MISSION DURATION	000.5 MONTHS
TECHNOLOGY DATE	1983
SIZE	8.7 X 4.0 dia (M)
WEIGHT/MASS	06515 (KG)
AVERAGE POWER	00.4 (KW) (TELESCOPE ONLY)
PEAK POWER	04.0 (KW)
DATA (I/O RATES)	0005.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0002.0 (ARC SEC)
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	REVISIT EVERY YEAR (FOR 10 YEARS)
LOGISTICS	CRYO COOLED 1250# EVERY 6 MONTHS
THERMAL/CNTRL COND	0.2 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1220.TXT

Shuttle Infrared Telescope Facility (SIRTF) is an astronomical telescope capable of accommodating photometric, spectroscopic, and polarimetric instruments. Helium vented at the rate of 0.5 g/sec. Avoid heat sources within 60 deg of FOV (90 deg for sun).

REQID	SA1230
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	T.P. STECHER, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	STARLAB
ALTITUDE	350-800 (KM)
INCLINATION	20-56 DEG
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	1984 (1989-90 LAUNCH
SIZE	5.0 X 1.5 dia (M)
WEIGHT/MASS	03280 (KG)
AVERAGE POWER	01.4 (KW)
PEAK POWER	01.9 (KW)
DATA (I/O RATES)	1600.0 (KBPS)
DATA (STORAGE CAP)	01200 (MBITS)
STABILITY	0010.0 (ARC SEC)
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	2 FLIGHTS PER YEAR FOR 10 YEARS
LOGISTICS	
THERMAL/CNTRL COND	0.2 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1230.TXT

Starlab is a space lab facility for astronomical observations in the visual and ultraviolet portion of the spectrum. Image motion compensation to reach 1 (arc sec) pointing acc. & 0.2 (arc sec) stability. Contamination problem during Shuttle visits.

Avoidance Angles:

35 deg - Sun
15 deg - Bright Moon
5 deg - Dark Earth

REQID	SA1240
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	B.G. DAVIS, MSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	ADVANCED X-RAY ASTROPHYSICS FACILITY
ALTITUDE	500 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	120 - 180 MONTHS
TECHNOLOGY DATE	1984
SIZE	13 X 1.3 dia (M)
WEIGHT/MASS	10000 - 12000 (KG)
AVERAGE POWER	02.0 (KW)
PEAK POWER	
DATA (I/O RATES)	1000.0 (KBPS)
DATA (STORAGE CAP)	01000 (MBITS)
STABILITY	0000.49 (ARC SEC)
POINTING ACC	0030.9 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1240.TXT

The Advanced X-RAY Astrophysics Facility will determine the positions of x-ray sources, their physical properties, and the processes involved in x-ray photon production.

REQID	SA1250
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	G. STOUFFER, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	SOLAR SOFT X-RAY TELESCOPE FACILITY
ALTITUDE	430 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	000.2 - 001.0 MONTHS
TECHNOLOGY DATE	1985
SIZE	6.0 X 1.2 dia (M)
WEIGHT/MASS	01300 (KG)
AVERAGE POWER	00.24 (KW)
PEAK POWER	00.36 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	0000.21 (ARC SEC)
POINTING ACC	0001.0 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	REVIST EVERY 6 - 12 MONTHS
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1250.TXT

Solar Soft X-Ray Telescope has as its purpose fundamental observations of the outer solar atmosphere.

REQID	SA1280
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	D. SUDDETH, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	SOLAR INTERIOR DYNAMICS MISSION (SIDM)
ALTITUDE	575 (KM)
INCLINATION	28 OR 98 DEG
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	1987
SIZE	6.0 X 2.0 dia (M)
WEIGHT/MASS	02600 (KG)
AVERAGE POWER	00.8 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	02000 (MBITS)
STABILITY	0000.41 (ARC SEC)
POINTING ACC	0001.0 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1280.TXT

Solar Interior Dynamics Mission will study long-term solar phenomena and short time-varying solar mechanisms.

REQID	SA1300
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	J. ORMES, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	COSMIC RAY OBSERVATORY
ALTITUDE	400 (KM)
INCLINATION	56 DEG
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	1987
SIZE	15.0 X 5.0 dia (M)
WEIGHT/MASS	18000 (KG)
AVERAGE POWER	02.0 (KW)
PEAK POWER	
DATA (I/O RATES)	0007.0 (KBPS)
DATA (STORAGE CAP)	00500 (MBITS)
STABILITY	
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1300.TXT

Cosmic Ray Observatory will study the composition and energy spectrum of primary cosmic rays.

REQID	SA1310
SOURCE	SSTM VOL 1, 9-81/SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	R. CHAPPELL, MSFC
DERIVATION	
FAMILY	PS/PH/GE
MISSION/EXPERIMENT	SOLAR TERRESTRIAL OBSERVATORY (STO)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	060 MONTHS
TECHNOLOGY DATE	1987
SIZE	80 X 15 X 9 (M)
WEIGHT/MASS	16500 (KG)
AVERAGE POWER	10.6 (KW)
PEAK POWER	20.35 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	0001.03 (ARC SEC)
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS/ORBITER RMS USED FOR RPOP DEPLOY
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1310.TXT

Solar Terrestrial Observatory contains hardware for 17 flight experiments and constitutes a mission in itself. The instruments are grouped onto two single pallets and a two-pallet train. One of the pallets contains a pointing mount. The Chemical Release Module (CRM), a free-flyer, will be launched separately. The STO instrument descriptive data were compiled by Teledyne Brown Engineering. Materials describing the STO payloads and mission are presented as developed by Programs Development, MSFC.

EMISSIONS/SUSCEPTIBILITES: Since STO occupies the whole Space Platform, emissions and suseptibilities are an internal matter. In general STO instruments are sensitive to H2O, CO2, and optical contaminants effective in the IR-visible-UV spectral regions. STO emits particle beams (electrons, He, and Ar) rf radiation (1-30 kHz 0.1-30 MHz, ~140 MHz, and ~400 MHz), laser light (IR-UV), and purge gases (Xe, CH4, and CO2).

VIEWING REQUIRMENTS: STO instruments have as variety of viewing requirements to include solar, limb, limb through solar occultation, nadir, and magnetic field pointing.

OPERATIONAL CONSIDERATIONS: The STO science objectives lie in the following areas: Solar Variability, Wave-Particle Processes, Magnetosphere-Ionsphere Mass Transport, Global Electric Circuit, Upper Atmospheric Dynamics, Middle Atmospheric Chemistry and Energetics, lower Atmospheric Turbidity, and Planetary Atmospheric Waves. Investigations in the above-listed areas require extensive simultaneous operation of the STO instruments.

REQID	SA1320
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	J.P. MURPHY, ARC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	LARGE AMBIENT DEPLOYABLE IR TELESCOPE
ALTITUDE	700 (KM)
INCLINATION	28 - 50 DEG
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	1987
SIZE	15 X 12 dia (M)
WEIGHT/MASS	20500 (KG)
AVERAGE POWER	05.0 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	0000.01 (ARC SEC)
POINTING ACC	0000.1 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1320.TXT

Large Ambient Deployable IR Telescope provides improved spatial resolution and energy collecting capability for the study of a wide variety of astrophysical phenomena.

REQID	SA1340
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	J. GITELMAN, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	X-RAY OBSERVATORY
ALTITUDE	400 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	< 1990
SIZE	
WEIGHT/MASS	03550 (KG)
AVERAGE POWER	00.9 (KW)
PEAK POWER	02.1 (KW)
DATA (I/O RATES)	0014.0-0150.0 (KBPS)
DATA (STORAGE CAP)	01000 (MBITS)
STABILITY	
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1340.TXT

X-Ray Observatory will make observations with broadband x-ray instruments to resolve fundamental questions in cosmology.

REQID	SA1350
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	E. MERCANT, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	LARGE AREA MODULAR ARRAY X-RAY TELESCOPE
ALTITUDE	400 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	< 1990
SIZE	3.42 X 4.42 dia (M)
WEIGHT/MASS	09289 (KG)
AVERAGE POWER	03.0 (KW)
PEAK POWER	
DATA (I/O RATES)	0125.0 (KBPS)
DATA (STORAGE CAP)	00500 (MBITS)
STABILITY	0010.0 (ARC SEC)
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	3 YEAR GAS SUPPLY
THERMAL/CNTRL COND	0.855 (KW)
OPERAT ENVIRON	
CONSUMABLES	637 (KG)
TEXT	SA1350.TXT

Large Area Modular Array of X-Ray Telescope will conduct a full-sky survey for x-ray sources. Vents 0.05 (g/hr) xenon/methane gas (90/10)

Avoidance angles:
- 60 deg - Sun
- 20 deg - Earth

REQID	SA1370
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	M. SANDER, SB-3
DERIVATION	
FAMILY	LS
MISSION/EXPERIMENT	SPACE LAB BIOLOGICAL AND MEDICAL EXPERIMENT
ALTITUDE	300 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	000.2 - 001.0 MONTHS
TECHNOLOGY DATE	1980
SIZE	15.0 X 4.5 dia (M)
WEIGHT/MASS	14000 (KG)
AVERAGE POWER	02.5 (KW)
PEAK POWER	06.5 (KW)
DATA (I/O RATES)	0064.0-16,000.0 (KBPS)
DATA (STORAGE CAP)	40000 (MBITS)
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	POCC
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1370.TXT

Spacelab Biological and Medical Experiments are to use the null gravity and altered environments of space to further the knowledge in medicine and biology for terrastrial as well as space needs.

REQID	SA1470
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	M. SANDER, SB-3
DERIVATION	
FAMILY	LS
MISSION/EXPERIMENT	SPACE SCIENCE PLATFORM
ALTITUDE	400 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	003 - 006 MONTHS EACH FOR 10 YEARS
TECHNOLOGY DATE	1982
SIZE	80 X 30 X 9 (M)
WEIGHT/MASS	60000 (KG)
AVERAGE POWER	15.0 (KW)
PEAK POWER	25.0 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	6 MEN
INTERFACES	TDRSS
SERVICE/MAINT	REVISIT EVERY 3-6 MONTHS
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1470.TXT

The Space Science Platform is a facility for long duration man flight experiments to increase the knowledge of the space environment in biological processes.

REQID	SA1480
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	H. MANNHEIMER, NASA HQ
DERIVATION	
FAMILY	PS/RO
MISSION/EXPERIMENT	LANDSAT D-D'
ALTITUDE	705 (KM)
INCLINATION	
ORBIT	POLAR, SUN SYNCHRONOUS
MISSION DURATION	036 MONTHS
TECHNOLOGY DATE	1980
SIZE	
WEIGHT/MASS	01597 (KG)
AVERAGE POWER	00.75 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1480.TXT

Landsat D and D' will provide data continuity of earth resources information for worldwide uses.

REQID	SA1500
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	T. FISCHETTI, NASA HQ
DERIVATION	
FAMILY	PS/RO
MISSION/EXPERIMENT	GRAVSAT A
ALTITUDE	160 (KM)
INCLINATION	
ORBIT	NEAR POLAR ORBIT
MISSION DURATION	009 MONTHS
TECHNOLOGY DATE	1983
SIZE	4.0 X 1.0 dia (M)
WEIGHT/MASS	04000 (KG)
AVERAGE POWER	00.15 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	00100 (MBITS)
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS,GPS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1500.TXT

Gravsat A will map the earth's gravity field at wavelenths of 100-1000 km and the mean ocean surface topography at wavelenths of 100-3000 km.

REQID	SA1530
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	K.J. ANDO, NASA HQ
DERIVATION	
FAMILY	PS/RO
MISSION/EXPERIMENT	ADVANCED LAND OBSERVING SYSTEM (ALOS)
ALTITUDE	705 (KM)
INCLINATION	
ORBIT	SUN SYNCHRONOUS
MISSION DURATION	060 MONTHS
TECHNOLOGY DATE	1984
SIZE	
WEIGHT/MASS	00315 (KG)
AVERAGE POWER	00.31 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1530.TXT

Advanced Land Observing System will provide an advanced land remote sensing capability in the late 1980's and beyond.

REQID	SA1590
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	R. ARNOLD, NASA HQ
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	GEOSTATIONARY OPERATIONAL ENVIRONMENT SATELLITE (GOES D,E,F)
ALTITUDE	35000 (KM)
INCLINATION	
ORBIT	GEO
MISSION DURATION	084 MONTHS
TECHNOLOGY DATE	1980
SIZE	
WEIGHT/MASS	00874 (KG)
AVERAGE POWER	00.33 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1590.TXT

The Geostationary Operational Environmental Satellite provides atmospheric sounding, continuous time and observations, and space environment monitoring.

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REQID	SA1600
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	S. TILFORD, NASA HQ
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	SOLAR MESOSPHERE EXPLORER (SME)
ALTITUDE	500 (KM)
INCLINATION	97.6 DEG
ORBIT	
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	1980
SIZE	1.1 X 0.9 dia (M)
WEIGHT/MASS	00155 (KG)
AVERAGE POWER	00.125 (KW)
PEAK POWER	00.16 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	00004 (MBITS)
STABILITY	> 1 ARC MIN
POINTING ACC	
MANNING	
INTERFACES	POCC
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1600.TXT

Solar Mesosphere Explorer provides a comprehensive study of atmospheric ozone and the processes which form and destroy it.

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REQID	SA1610
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	D. DILLER
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	EARTH RADIATION BUDGET SATELLITE
ALTITUDE	600 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	1980
SIZE	
WEIGHT/MASS	02000 (KG)
AVERAGE POWER	00.54 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1610.TXT

Earth's Radiation Budget Satellite will develop a global system for measuring the components of the earth's radiation budget.

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REQID	SA1620
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	J. ARNOLD, NASA HQ
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	NOAA AG/TIROS-N
ALTITUDE	830 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	1980
SIZE	
WEIGHT/MASS	00740 (KG)
AVERAGE POWER	00.46 (KW)
PEAK POWER	
DATA (I/O RATES)	2660.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1620.TXT

The NOAA AG/TIROS-N program will develop a third-generation operational prototype satellite to be incorporated into the operational system upon depletion of ITOS spacecraft.

REQID	SA1630
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	R. McNEAL, NASA HQ
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	UPPER ATMOSPHERIC RESEARCH SATELLITES (UARS)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	018 MONTHS
TECHNOLOGY DATE	1982
SIZE	5.75 X 3.0 (M) PLATFORM
WEIGHT/MASS	02367 (KG)
AVERAGE POWER	01.339 (KW) EACH
PEAK POWER	
DATA (I/O RATES)	0013.9 (KBPS)
DATA (STORAGE CAP)	00100 (MBITS)
STABILITY	
POINTING ACC	0036.0 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	CLES VENTS HYDROGEN
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1630.TXT

The Upper Atmosphere Research Satellites will study the radiation, chemistry, and dynamics of the stratosphere, mesosphere, and thermosphere, and the coupling between these properties.
Targets: Sun, solar occulation, stars,earth's limb
(45, 135, 90,& 270 deg azimulth)
Sensitive to UV thru IR spectrum, microwave interference, and disposition on optics.

REQID	SA1640
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	W. TOWNSEND, NASA HQ
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	OCEAN CIRCULATION MISSION-TOPOGRAPHY EXPERIMENT (TOPEX)
ALTITUDE	300 (KM)
INCLINATION	65 DEG
ORBIT	
MISSION DURATION	060 MONTHS
TECHNOLOGY DATE	1983
SIZE	
WEIGHT/MASS	01350 (KG)
AVERAGE POWER	00.65 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1640.TXT

Ocean Circulation Mission--Topography Experiment (TOPEX) will map the surface topography of the ocean.

REQID	SA1670
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	L. KEAFER, NASA LRC
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	LOWER ATMOSPHERIC RESEARCH SATELLITE (LARS)
ALTITUDE	780 (KM)
INCLINATION	60-98.2 DEG
ORBIT	
MISSION DURATION	036 MONTHS
TECHNOLOGY DATE	
SIZE	
WEIGHT/MASS	01170 (KG)
AVERAGE POWER	01.7 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1670.TXT

The Low Altitude Research Satellite will monitor the troposphere from space.

C-2

REQID	SA1700
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	T. McGUNIGAL, NASA HQ
DERIVATION	
FAMILY	SO/COM
MISSION/EXPERIMENT	SEARCH AND RESCUE MISSION
ALTITUDE	834 (KM)
INCLINATION	98.8 DEG
ORBIT	
MISSION DURATION	012 - 024 MONTHS
TECHNOLOGY DATE	1980
SIZE	
WEIGHT/MASS	00850 (KG)
AVERAGE POWER	00.098 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1700.TXT

Search and Rescue Mission provides the technical basis for a world-wide satellite aided search and rescue system.

REQID	SA1730
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	G. KNOUSE, NASA HQ
DERIVATION	
FAMILY	SO/COM
MISSION/EXPERIMENT	MULTI-SERVICE THIN ROUTE NARROWBAND PROGRAM
ALTITUDE	35000 (KM)
INCLINATION	
ORBIT	GEO
MISSION DURATION	084 - 240 MONTHS
TECHNOLOGY DATE	1984
SIZE	14-55 dia (M)
WEIGHT/MASS	02300 (KG)
AVERAGE POWER	08.0 - 10.0 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	0016.5 (ARC SEC)
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1730.TXT

Multi-Service Thin Route Narrowband Program will demonstrate satellite technology and economic viability in the UHF-S band spectrum for fixed and mobile users.

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REQID	SA1750
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	M. McDONALD, NASA HQ
DERIVATION	
FAMILY	SO/ST
MISSION/EXPERIMENT	MULTIMISSION MODULAR SPACECRAFT
ALTITUDE	500-1600 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	1980
SIZE	1.7 X 2.0 (M)
WEIGHT/MASS	00665 (KG)
AVERAGE POWER	01.2 (KW)
PEAK POWER	02.0 (KW)
DATA (I/O RATES)	0512.0-1024.0 (KBPS)
DATA (STORAGE CAP)	00300 (MBITS)
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	GSTDN,TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1750.TXT

Multimission Modular Spacecraft provides a standard spacecraft bus that can be used for a range of missions.

REQID	SA1790
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	E. JAMES, NASA HQ
DERIVATION	
FAMILY	SO/SE
MISSION/EXPERIMENT	SPACELAB
ALTITUDE	400 (KM)
INCLINATION	
ORBIT	LEO
MISSION DURATION	000.2 - 001.0 MONTHS
TECHNOLOGY DATE	1980
SIZE	7 X 4.1 dia (M)
WEIGHT/MASS	06200 (KG)
AVERAGE POWER	04.0 (KW)
PEAK POWER	09.0 (KW)
DATA (I/O RATES)	1000.0-10,000.0 (KBPS)
DATA (STORAGE CAP)	00300 - 03000 (MBITS)
STABILITY	/
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	5-20 FLIGHTS PER YEAR
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1790.TXT

The purpose of Spacelab is to provide ready access to space for a broad spectrum of experimenters in many fields and from many nations.

REQID	SA1830
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	M. NOLAN, NASA HQ
DERIVATION	
FAMILY	SO/SE
MISSION/EXPERIMENT	POWER UTILIZATION PLATFORM - ALPHA(PUP-a)
ALTITUDE	435 (KM)
INCLINATION	28.5 or 57 DEG
ORBIT	
MISSION DURATION	060 MONTHS
TECHNOLOGY DATE	1983
SIZE	120 X 50 X 25 (M)
WEIGHT/MASS	12500 (KG)
AVERAGE POWER	11.0 - 12.0 (KW)
PEAK POWER	66.7 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	00500 (MBITS)
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1830.TXT

The Power Utilization Platform - Alpha will be a Shuttle-deployed and Shuttle-tended facility, placed in low earth orbit for an indefinite time, and intended to provide stability, pointing, communications, power, and thermal dissipation services to a variety of temporarily emplaced payloads.

REQID	SA1840
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	W. SMITH, NASA HQ
DERIVATION	
FAMILY	SO/SE
MISSION/EXPERIMENT	SATELLITE SERVICES REMOTE FROM ORBITER
ALTITUDE	999 - 1600 (KM)
INCLINATION	28.5 TO POLAR
ORBIT	LEO TO GEO
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	1984
SIZE	3.3 X 3.2 X 3.4 (M)
WEIGHT/MASS	06000 (KG)
AVERAGE POWER	00.55 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1840.TXT

The Satellite Services Remote from Orbiter program will develop and demonstrate satellite servicing capability at standoff distances from the Orbiter of up to 1600 km.

REQID	SA1850
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	M NOLAN, MTG-3
DERIVATION	
FAMILY	SO/SE
MISSION/EXPERIMENT	SPACE STATION
ALTITUDE	370-405 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	1986
SIZE	14 (M) LENTH
WEIGHT/MASS	59000 (KG)
AVERAGE POWER	50.0 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	4 MEN
INTERFACES	
SERVICE/MAINT	REVIST 90 DAYS
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1850.TXT

Space Station is a Shuttle-serviced, permanently manned facility in near space.

REQID	SA1860
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	M. NOLAN, MTG-3
DERIVATION	
FAMILY	SO/SE
MISSION/EXPERIMENT	POWER UTILIZATION PLATFORM - BETA(PUP-b)
ALTITUDE	400 KM
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	1988
SIZE	
WEIGHT/MASS	13000 - 16000 (KG)
AVERAGE POWER	10.0 - 25.0 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	REVIST 6 MONTHS
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA1860.TXT

Power Utilization Platform - Beta is an evolutionary growth version of the Power Utilization Platform - Alpha.

REQID	SA2080
SOURCE	SSTM VOL 1, 9-81
CONTACT/AUTHOR	P. SWANSON, JPL
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	ORBITING INFRARED SUBMILLIMETER TELESCOPE (OIST)
ALTITUDE	700 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	> 1990
SIZE	10-15 dia (M)
WEIGHT/MASS	10000 (KG)
AVERAGE POWER	00.5 (KW)
PEAK POWER	01.0 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	0002.0 (ARC SEC)
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2080.TXT

The Orbiting Infrared Submillimeter Telescope can carry out a wide range of astrophysical observations in a spectral region that is not accessible to ground-based observatories because of the absorption by the terrestrial atmosphere.

REQID	SA2090
SOURCE	SSTM VOL 3, 9-81
CONTACT/AUTHOR	J. MURPHY, ARC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	INFRARED INTERFEROMETER
ALTITUDE	400-700 (KM)
INCLINATION	28-50 DEG
ORBIT	
MISSION DURATION	060 MONTHS
TECHNOLOGY DATE	> 1990
SIZE	100 X 15 X 9 (M)
WEIGHT/MASS	22500 (KG)
AVERAGE POWER	25.0 (KW)
PEAK POWER	59.0 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	10000 (MBITS)
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2090.TXT

The Infrared Interferometer will make high-resolution studies of galactic nuclei, protostars, young stellar objects, circum-stellar shells, and binary systems in order to elucidate the physical processes in galactic cores, the dynamics of stellar formation, and the interaction of gas and radiation in planetary nebulae.

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REQID	SA2110
SOURCE	SSTM VOL 3, 9-81
CONTACT/AUTHOR	M. NEIN, MSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	COHERENT OPTICAL SYSTEM OF MODULAR IMAGING COLLECTOR (COSMIC)
ALTITUDE	500 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	> 1990
SIZE	12 X 4 dia (M)
WEIGHT/MASS	67000 (KG)
AVERAGE POWER	25.0 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	10000 (MBITS)
STABILITY	0000.0004 (ARC SEC)
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2110.TXT

Coherent Optical System of Modular Imaging Collectors (COSMIC) will increase the capabilities of UV Optical/IR astronomy by several orders of magnitude more than Space Telescope.

REQID	SA2120
SOURCE	SSTM VOL 3, 9-81
CONTACT/AUTHOR	M. NEIN, MSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	100-METER THINNED APERATURE TELESCOPE
ALTITUDE	500 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	> 1990
SIZE	100 dia (M)
WEIGHT/MASS	85000 (KG)
AVERAGE POWER	25.0 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	10000 (MBITS)
STABILITY	0000.0001 (ARC SEC)
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2120.TXT

The 100-Meter Thinned Aperture Telescope (TAT) has its basic objectives a 30-fold increase in image resolution and a 1000-fold increase in astrometric precision over that afforded by the Space Telescope.

REQID	SA2130
SOURCE	SSTM VOL 3, 9-81
CONTACT/AUTHOR	J. BALLANCE, MSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	VERY LONG BASELINE UV/OPTICAL/IR INTERFEROMERTER
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	
WEIGHT/MASS	01400 (KG)
AVERAGE POWER	00.9 (KW)
PEAK POWER	
DATA (I/O RATES)	12000 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2130.TXT

The objectives of the Very Long Basesline UV/Optical/IR Interferometer have not yet been determined.

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REQID	SA2140
SOURCE	SSTM VOL 3, 9-81
CONTACT/AUTHOR	M. NEIN, MSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	VERY LARGE SPACE TELESCOPE (VLST)
ALTITUDE	425 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	120 MONTHS
TECHNOLOGY DATE	> 1990
SIZE	28.25 X 8.4 dia (M)
WEIGHT/MASS	22850 (KG)
AVERAGE POWER	06.0 (KW)
PEAK POWER	12.0 (KW)
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	0000.002 (ARC SEC)
POINTING ACC	
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2140.TXT

The Very Large Space Telescope will increase the sensitivity and angular resolution available to UV/Optical/IR astronomy by an order of magnitude above the Space Telescope.

REQID	SA2180
SOURCE	SSTM VOL 3, 9-81
CONTACT/AUTHOR	W. HIBBARD, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	SOFT X-RAY EXPLORER
ALTITUDE	400 (KM)
INCLINATION	28 DEG
ORBIT	
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	
SIZE	
WEIGHT/MASS	01300 (KG)
AVERAGE POWER	00.14 (KW)
PEAK POWER	
DATA (I/O RATES)	0002.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2180.TXT

The Soft X-Ray Explorer will perform an all-sky survey in the soft x-ray (0.1 to 3.0 keV) spectral range.

REQID	SA2190
SOURCE	SSTM VOL 3, 9-81
CONTACT/AUTHOR	W. HIBBARD, GSFC
DERIVATION	
FAMILY	PS/PH
MISSION/EXPERIMENT	GAMMA-RAY TRANSIENT EXPLORER (GTE)
ALTITUDE	450 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	024 MONTHS
TECHNOLOGY DATE	
SIZE	
WEIGHT/MASS	03000 (KG)
AVERAGE POWER	01.5 - 02.0 (KW)
PEAK POWER	
DATA (I/O RATES)	0010.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2190.TXT

The Gamma-Ray Transient Explorer will be used to study both the recently discovered cosmic gamma-ray transients, with all-sky coverage and with very accurate positional and spectral measurements, and solar flare gamma-ray transients.

REQID	SA2470
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	J. HILCHEY, PS02, MSFC
DERIVATION	
FAMILY	LS
MISSION/EXPERIMENT	LIFE SCIENCES PAYLOAD #1 (LS-1)
ALTITUDE	400 (KM)
INCLINATION	
ORBIT	ANY/LEO
MISSION DURATION	006 MONTHS
TECHNOLOGY DATE	
SIZE	1.07 X 4.46 dia (M)
WEIGHT/MASS	01770 (KG)
AVERAGE POWER	00.62 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	FREON PUMP PACKAGE
SERVICE/MAINT	90 DAY REVISIT
LOGISTICS	
THERMAL/CNTRL COND	HEAT REJECTION 0.65 (KW)
OPERAT ENVIRON	LOW G
CONSUMABLES	
TEXT	SA2470.TXT

LS-1 is a minimum configuration, unmanned life sciences facility. The concept is based on individual animal and plant containers carried on an MPE Support Structure with associated life support and integration hardware. Six rat containers and twelve plant containers are included. The life support system is sized for nominal 90 day service intervals.

REQID	SA2480
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	J. HILCHEY, PS02, MSFC
DERIVATION	
FAMILY	LS
MISSION/EXPERIMENT	LIFE SCIENCES PAYLOAD #2 (LS-2)
ALTITUDE	400 (KM)
INCLINATION	
ORBIT	ANY/LEO
MISSION DURATION	006 MONTHS
TECHNOLOGY DATE	
SIZE	2.69 X 2.90 dia (M)
WEIGHT/MASS	02500 (KG)
AVERAGE POWER	01.1 (KW)
PEAK POWER	01.1 (KW)
DATA (I/O RATES)	0020.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	FREON PUMP PACKAGE
SERVICE/MAINT	90 DAY REVISIT
LOGISTICS	
THERMAL/CNTRL COND	HEAT REJECTION 1.2 (KW)
OPERAT ENVIRON	LOW G
CONSUMABLES	
TEXT	SA2480.TXT

LS-2 is a pressurized life sciences research facility which will house 24 rats and 24 mice (or equivalent). It contains life support systems, a centrifuge which provides a 1-g environment for half the animals, and integration hardware. Life support gases are contained in externally mounted bottles. The life support system is sized for nominal 90 day service interval.

REQID	SA2490
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	METEOROLOGY PAYLOAD
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	1.6 X 4.81 X 2.69 (M)
WEIGHT/MASS	01170 (KG)
AVERAGE POWER	01.14 (KW)
PEAK POWER	
DATA (I/O RATES)	0014.2 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0006.0 (ARC SEC)
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	0.74 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2490.TXT

The payload contains AMTS, AMSU, and MPS with integration hardware.
The payload is carried on an MPE support structure or equivalent.

REQID	SA2500
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	OCEAN PAYLOAD
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	9.6 X 4.0 X 1.5 (M)
WEIGHT/MASS	01736 (KG)
AVERAGE POWER	00.965 (KW)
PEAK POWER	
DATA (I/O RATES)	1106.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	0.565 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2500.TXT

The payload contains the Ocean Microwave Package, Scatterometer, Microwave Radiometer, and Color Scanner with integration hardware. A special carrier is assumed since the payload occupies the equivalent of more than two Spacelab pallets.

REQID	SA2510
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	SPACE PLASMA PHYSICS (SPP) PAYLOAD
ALTITUDE	300-400 (KM)
INCLINATION	57-90 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	4.4 X 4.46 X 3.4 (M)
WEIGHT/MASS	03183 (KG)
AVERAGE POWER	02.665 (KW)
PEAK POWER	08.885 (KW)
DATA (I/O RATES)	0277.0-7000.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0060.0 (ARC SEC)
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	1.84 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2510.TXT

The SPP payload contains the SEPAC, WISP, and AEPI instruments. The integration hardware includes an active thermal control loop, a shelf on which to mount the SEPAC electron gun, MPD arcjet, and instruments, and a special struture for mounting the WISP dipole antenna. The SPP payload is packaged on a Spacelab pallet.

REQID	SA2520
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/GE/PH
MISSION/EXPERIMENT	UPPER ATMOSPHERE RESEARCH SATELLITE (UARS)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	5.8 X 3.0 X 3.9 (M)
WEIGHT/MASS	02367 (KG)
AVERAGE POWER	01.339 (KW)
PEAK POWER	
DATA (I/O RATES)	0013.9 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	0.849 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2520.TXT

Payload contains UARS instrument group (HALOE, TWM, CLAES, ISAMS, MLS, HRDI, USSIE, and SUSIM) plus integration hardware. It is anticipated that a special carrier struture would be utilized which would satisfy the viewing requirements of the instrument group and optimize utilization of the Orbiter cargo envelope.

REQID	SA2560
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	J. WELLMAN, JPL
DERIVATION	
FAMILY	SO/GE
MISSION/EXPERIMENT	IMAGING SPECTROMETER (IS) PAYLOAD
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	012 MONTHS
TECHNOLOGY DATE	
SIZE	
WEIGHT/MASS	01938 (KG)
AVERAGE POWER	02.77 (KW)
PEAK POWER	03.94 (KW)
DATA (I/O RATES)	1000.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0000.04 (ARC SEC)
POINTING ACC	0036.0 (ARC SEC)
MANNING	
INTERFACES	TDRSS
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2560.TXT

Payload contains the IS instrument, a two axis pointing system, and other integration hardware packaged on a Spacelab pallet. IS would like to observe the same targets as SAR. Six operations per orbit is minimum requirement. More operations are desirable. Some leakage of nitrogen possible.

REQID	SA2570
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	
DERIVATION	
FAMILY	SO/SE
MISSION/EXPERIMENT	ELECTROPHORESIS OPERATIONS IN SPACE (EOS)
ALTITUDE	400 (KM)
INCLINATION	
ORBIT	ANY/LEO
MISSION DURATION	006 MONTHS
TECHNOLOGY DATE	
SIZE	1.22 X 4.27 dia (M) EACH MODULE
WEIGHT/MASS	04891 (KG)
AVERAGE POWER	03.5 (KW)
PEAK POWER	03.5 (KW)
DATA (I/O RATES)	0000.001 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	RESUPPLY MODULES EXCHANGED EVERY 6 MONTH
LOGISTICS	
THERMAL/CNTRL COND	3.5 (KW)
OPERAT ENVIRON	LOW G
CONSUMABLES	VENTS 0.71 KG/DAY OF WATER
TEXT	SA2570.TXT

The EOS facility comes in two modules, a production module and a resupply module. The production module remains on orbit while resupply modules are exchanged every 6 months. The current EOS concept requires an interloop heat exchanger (freon-water) and other integration hardware to adapt to the Space Platform. EOS provides its own carrier structure.

REQID	SA2580
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	
DERIVATION	
FAMILY	SO/SE
MISSION/EXPERIMENT	MATERIALS EXPERIMENT ASSEMBLY (MEA)
ALTITUDE	400 (KM)
INCLINATION	
ORBIT	ANY/LEO
MISSION DURATION	005 MONTHS
TECHNOLOGY DATE	
SIZE	1.2 X 4.2 dia (M)
WEIGHT/MASS	02315 (KG)
AVERAGE POWER	05.0 (KW)
PEAK POWER	
DATA (I/O RATES)	0000.6-0006.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	RAU/FMDM/HRM/PDI
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	LOW G
CONSUMABLES	
TEXT	SA2580.TXT

The facility conducts a series of materials processing cycles in series. Cycle durations run from 3 to 30 days. Continuous operation desired within each cycle but break points would exist between cycles. MEA vents small amounts of air (4.06 kg), helium (0.08 kg), and argon (0.13 kg) during the 150 day operating duration.

REQID	SA2590
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	R. WILSON, JPL
DERIVATION	SA1310
FAMILY	PS/PH/I
MISSION/EXPERIMENT	ACTIVE CAVITY RADIOMETER (ACR)
ALTITUDE	120 - 500 (KM)
INCLINATION	
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	0.299 X 0.229 X 0.337 (M)
WEIGHT/MASS	00020 (KG)
AVERAGE POWER	00.010 (KW)
PEAK POWER	00.013 (KW)
DATA (I/O RATES)	0000.217 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	TEMP. LIMITS 283-343 DEG (K)
THERMAL/CNTRL COND	00.010 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2590.TXT

ACR is an electrically self calibrating, cavity detector pyrheliometer capable of defining the absolute radiation scale with an accuracy better than 0.2%. It measures solar irradiance from far ultraviolet through far infrared. ACR contains three identical detectors which are used simultaneously. Continuous operation is desired when the sun is available.

REQID	SA2600
SOURCE	SP82-MSFC-2583
CONTACT/AUTHOR	G. BRUECKNER, NRL
DERIVATION	SA1310/SA2520
FAMILY	PS/PH/I
MISSION/EXPERIMENT	SOLAR (UV) SPECTRAL IRRADIANCE MONITOR (SUSIM)
ALTITUDE	400 (KM)
INCLINATION	28.5 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	0.86 X 0.77 X 0.28 (M)
WEIGHT/MASS	0083.7 (KG)
AVERAGE POWER	00.123 (KW)
PEAK POWER	00.153 (KW)
DATA (I/O RATES)	0000.53 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	TEMP. LIMITS 288-298 DEG (K)
THERMAL/CNTRL COND	0.153 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2600.TXT

SUSIM measures the far ultraviolet flus spectrum from the entire sun in the wavelengh range 120-400 nm, with a resolution of 0.1 nm. The goals are to improve the accuracy of absolute solar fluxes and to study both long (solar cycle - 11 years) term and short term (minutes) variation of the solar flux. Two modes of operation are used, continuously monitoring fixed wavelengths and continuously scanning the spectrum. Calibration using the deuterium lamp will be performed once per day (25 minutes). Alignment verification (step scan) will be performed as needed (40 minutes).

REQID	SA2610
SOURCE	USER CONTACTS
CONTACT/AUTHOR	
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	OCEANOGRAPHIC OBSERVATORY
ALTITUDE	400 (KM)
INCLINATION	65 DEG
ORBIT	300 (KM) AT 28.5 DEG, MARGINALLY USEFUL
MISSION DURATION	10 YEARS USEFUL OPERATION
TECHNOLOGY DATE	1985
SIZE	9.2 X 4.3 dia (M)
WEIGHT/MASS	14000 (KG)
AVERAGE POWER	01.5 (KW)
PEAK POWER	05.0 (KW)
DATA (I/O RATES)	1000.0 (KBPS)
DATA (STORAGE CAP)	20000.0 - 40000.0 (MBITS)
STABILITY	0001.3 (ARC SEC)
POINTING ACC	0000.2 (ARC SEC)
MANNING	2 MEN (MINIMUM)
INTERFACES	TDRSS
SERVICE/MAINT	6 MONTHS (RE-CREW)
LOGISTICS	EVA
THERMAL/CNTRL COND	0.5 - 1.5 (KW) HEAT DISSIPATION
OPERAT ENVIRON	LOW - G
CONSUMABLES	NO INSTRUMENTATION PECULIAR NEEDS
TEXT	SA2610.TXT

The OCEANOGRAPHIC OBSERVATORY payload contains the SAR, Altimeter, Scatterometer, single channel Microwave Radiometer, and SSMI Microwave Imager. The sensors will operate over the complete wavelenth spectrum. The need for an experimental laboratory in space in which multi-sensor systems can be developed and correlated with observations from space to expand existing capabilities and to expand our understanding of the data has bean recognized. Long duration flights (30 - 60 days minimum) are required to accomplish this objective, since the long-time behavior of dynamic ocean phenoma is of prime interest. Initial requirements are for the experimenter to control the pointing of or control the duty cycles of the instruments. A desirable capability is to be able to change out or re-configure equipment on-orbit.

REQID	SA2620
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	A. LOOMIS, JPL
DERIVATION	
FAMILY	PS/GE
MISSION/EXPERIMENT	SYNTHETIC APERATURE RADAR (SAR)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	4.1 X 2.6 X 0.5 (M)
WEIGHT/MASS	01876 (KG)
AVERAGE POWER	06.0 (KW)
PEAK POWER	06.5 (KW)
DATA (I/O RATES)	120000 (KBPS)
DATA (STORAGE CAP)	TBD
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	FMDM
SERVICE/MAINT	NO LIMITING FACTORS IDENTIFIED
LOGISTICS	
THERMAL/CNTRL COND	5.4 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2620.TXT

Payload contains the SAR instrument plus integration hardware and a Spacelab pallet. The SAR antenna folds for launch/return and deploys on orbit for operation. The antenna would mount lenthwise or crosswise to the carrier as necessary to achieve orientation parallel to the velocity vector during operation.

TARGET DESCRIPTION: The entire earth's surface is potential target. Complete coverage of land masses for mapping is an early objective. Agricultural studies prefer repetitive observations on time scales of weeks, typically. Ocean and ice studies prefer repetitive observations on short time scales.

Six operations per day minimum. One operation per orbit of 15-20 minute duration during pass over specified target areas. More operations are desirable. Altitude must be known to set transmitter power and trans- mission/reception timing. Operating sequence change required if altitude changes by ~35 km. Orbit should be circular to +-4 km. The SAR requires a clear field of view 6 X 60 degrees.

The SAR radiates high power, pulsed radio frequency energy at 1.2 and 5.3 or 9.6 GHz. Bandwidth is ~20 MHz at each band. It is susceptible to radio frequency interference.

REQID	SA2630
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA2490
FAMILY	PS/GE/I
MISSION/EXPERIMENT	ADVANCED MICROWAVE SOUNDING UNIT (AMSU)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	0.5 X 1.6 X 0.6 (M)
WEIGHT/MASS	00080 (KG)
AVERAGE POWER	00.17 (KW)
PEAK POWER	
DATA (I/O RATES)	0003.6 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2630.TXT

The AMSU is a 20 channel microwave radiometer which measures the vertical profile of atmospheric temperature and moisture for input to numerical weather prediction models. It will also measure precipitation distri- bution and intensity. Ground resolution is 50 km for channels 1-15 and 15 km for channels 16-20.

EMISSIONS/SUSCEPTIBILITIES: Susceptible to microwave radiation at the observing frequencies. Water vapor and oxygen lines are used for several channels.

OPERATIONAL REQUIREMENTS: Requires global coverage at least twice daily. The instrument scans +-50 deg cross track with an 8 sec scan period.

REQID	SA2640
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA2490
FAMILY	PS/GE/I
MISSION/EXPERIMENT	ADVANCED MOISTURE AND TEMPERATURE SOUNDER (AMTS)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	1.0 X 1.4 X 0.8 (M)
WEIGHT/MASS	00300 (KG)
AVERAGE POWER	00.15 (KW)
PEAK POWER	
DATA (I/O RATES)	0003.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2640.TXT

The AMTS is a 28 channel infrared spectrometer which measures vertical profils of atmospheric temperature and moisture for input to numerical weather prediction models.

EMISSIONS/SUSCEPTIBILITIES: Susceptible to emission, absorption or scat- tering of infrared radiation in the field of view and to condensation on optical surfaces.

OPERATIONAL REQUIREMENTS: Requires global coverage at least twice daily.

REQID	SA2650
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA2490
FAMILY	PS/GE/I
MISSION/EXPERIMENT	MICROWAVE PRESSURE SOUNDER (MPS)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	1.5 X 0.6 X 0.5 (M)
WEIGHT/MASS	00050 (KG)
AVERAGE POWER	00.42 (KW)
PEAK POWER	
DATA (I/O RATES)	0007.6 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2650.TXT

The MPS is an active microwave sensor using up to 6 channels to measure surface (sea level) pressure of the atmosphere for input to numerical weather prediction models.

EMISSIONS/SUSCEPTIBILITIES: MPS radiates microwave rf energy. It is susceptible to microwave interference at the operating frequencies.

OPERATIONAL REQUIREMENTS: Global coverage desirable but not mandatory.

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REQID	SA2660
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA2500/SA2610
FAMILY	PS/GE/I
MISSION/EXPERIMENT	COLOR SCANNER
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	0.56 X 0.86 X 0.41 (M)
WEIGHT/MASS	00050 (KG)
AVERAGE POWER	00.085 (KW)
PEAK POWER	
DATA (I/O RATES)	1080.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	
MANNING	
INTERFACES	RAU/FMDM/HRM/PDI
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2660.TXT

The Color Scanner is a nine channel, scanning radiometer operating in the visible and infrared portion of the spectrum. It measures the ocean color, from which chlorophyll concentration, and thereby phytoplankton abundance can be inferred.

EMISSIONS/SUSCEPTIBILITIES: Susceptible to absorption, emission or scat- tering in the visible and infrared.

OPERATIONAL REQUIREMENTS: Desirable to operate continuously over ocean when sun angle is acceptable. Sun angle must be within +-30 degrees of nadir.

SPECIAL CONSIDERATIONS: Requires clear field of view +- 40 degrees from nadir, crosstrack. Space view required for calibration.

REQID	SA2670
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA2500/SA2610
FAMILY	PS/GE/I
MISSION/EXPERIMENT	MICROWAVE RADIOMETER
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	0.153 X 0.495 X 0.204 & 0.8 (M) ANT.
WEIGHT/MASS	00055 (KG)
AVERAGE POWER	00.065 (KW)
PEAK POWER	
DATA (I/O RATES)	0002.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/FMDM/HRM/PDI
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2670.TXT

The Microwave Radiometer is a passive, 5 channel, scanning radiometer which measures the sea surface temperature, atmospheric water vapor, and ice cover.

EMISSIONS/SUSCEPTIBILITIES: Susceptible to microwave radiation at the operating frequencies.

OPERATIONAL REQUIREMENTS: The antenna boresight must be pointed approx- imately 40 degrees forward of aft of nadir, and a clear field of view is required 25 deg cross track. Continuous operation over ocean is des- irable both day and night.

REQID	SA2680
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA2500/SA2610
FAMILY	PS/GE/I
MISSION/EXPERIMENT	OCEAN MICROWAVE PACKAGE
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	SEE SPECIAL CONSIDERATIONS
WEIGHT/MASS	00200 (KG)
AVERAGE POWER	00.2 (KW)
PEAK POWER	
DATA (I/O RATES)	0020.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/FMDM/HRM/PDI
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2680.TXT

The Ocean Microwave Package contains two active instruments, the Multibeam Altimeter (MA) and the Directional Wave Spectrometer (DWS). MA uses two antennas to interferometrically generate multiple radar beams either side of nadir. DWS scans a 10 deg half angle cone around nadir.

EMISSIONS/SUSCEPTIBILITIES: The instruments radiate and are susceptible to rf energy at 13.7 GHz.

OPERATIONAL REQUIREMENTS: Continuous operation is desirable over oceans, day or night. Clear field of view is required 10 deg around nadir.

SPECIAL CONSIDERATIONS:
2 - 1 m diameter antennas separated by 11 m during operation
1 - 3 m diameter conically scanning antenna
1 - 2 m diameter x 0.8 m nadir viewing antenna
1 - 0.51 x 0.34 x 0.25 m box

REQID	SA2690
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA2500/SA2610
FAMILY	PS/GE/I
MISSION/EXPERIMENT	SCATTEROMETER
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	SEE SPECIAL CONSIDERATIONS
WEIGHT/MASS	00160 (KG)
AVERAGE POWER	00.215 (KW)
PEAK POWER	
DATA (I/O RATES)	0004.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/FMDM/HRM/PDI
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2690.TXT

The Scatterometer is a multiple beam radar which measures wind speed and direction over a wide swath either side of nadir.

EMISSIONS/SUSCEPTIBILITIES: The Scatterometer radiates and is susceptible to 14.6 GHz radiation.

OPERATIONAL REQUIREMENTS: Desirable to operate continuously over ocean both day and night. Clear field of view required approximately 45 degrees either side of nadir.

SPECIAL CONSIDERATIONS:
Requires auxillary rain detection.
Six antennas-3.1 x 0.099 x 0.15 m
One box-1.15 x 0.55 x 0.31 m

REQID	SA2700
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	R. ISE, MSFC
DERIVATION	SA2510/SA1310
FAMILY	PS/GE/I
MISSION/EXPERIMENT	ATMOSPERIC PHOTOMETRIC IMAGING (AEPI)
ALTITUDE	250 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	1.4 X 0.47 X 1.4 (M)
WEIGHT/MASS	00174 (KG)
AVERAGE POWER	00.34 (KW)
PEAK POWER	00.56 (KW)
DATA (I/O RATES)	0277.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	
MANNING	
INTERFACES	RAU/FMDM/VIDEO
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	00.34 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2700.TXT

AEPI consists of a dual channel, low light level video system mounted on a stabilized two-axis gimbal system, with associated optics and data hand- ling electronics. The mount is a Modified Apollo Star Tracker (MAST).

AEPI observes the ground footprint of the SEPAC charged particle beam, the SEPAC beam as it exists the accelerator, and natural auroras. Most oper- ations will be coordinated with SEPAC, although the possibility exists of independent observations of natural auroras at high latitude, and observa- tions of terminator and magnetic equator crossings.

The observations are photometric video images of natural and induced atmo- spheric emission, and of the beams produced by SEPAC. Observations of natural emission are performed in the auroral zones. Coordination with SEPAC is required for observations of induced emission. A typical obser- vation will last 10-15 minutes. Operation scheduling for induced emission is a function of geomagnetic coordinates.

SEPAC is scheduled for SPACELAB-1 flight.

REQID	SA2710
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	B. ROBERTS, MSFC
DERIVATION	SA2510/SA1310
FAMILY	PS/GE/I
MISSION/EXPERIMENT	SPACE EXPERIMENTS WITH PARTICLE ACCELATORS (SEPAC)
ALTITUDE	250 (KM)
INCLINATION	57-90 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	0.75 X 0.56 X 1.75 (M)
WEIGHT/MASS	00637 (KG)
AVERAGE POWER	00.10 (KW)
PEAK POWER	00.30 (KW)
DATA (I/O RATES)	0512.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN/> 1 DEG
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	RAU/FMDM/VIDEO/WIDEBAND ANALOG
SERVICE/MAINT	FLIGHT DURATION LIMITED BY GAS SUPPLY
LOGISTICS	GAS RESUPPLY
THERMAL/CNTRL COND	0.5 (KW) PASSIVE-1.75 (KW) BEAM FIRING
OPERAT ENVIRON	
CONSUMABLES	20 (KG) He,Ar,N2 or Xe
TEXT	SA2710.TXT

SEPAC as an active instrument, generates a disturbance in the vicinity of the spacecraft and observes the interaction of the emitted beam with the space plasma and atmosphere. Operations will be driven by geomagnetic field pointing geographic locations, and lighting requirements. Emphasis on UV-Vis-IR mea- surments/observations creates preference/requirement for dark side operation. Opportunities vary with time/position in orbit but are predictable. E-beam/ plasma gun firing (~5 min.) would occur 3-4 times per orbit mostly on the dark side. Intensive operation ~1 week/month would be satisfactory. Coordination with ground sites within 150 km of ground track is of some interest for optical and radio observations. MPD/NGP provides charge neutralization for most FO~s using the EBA.

Primary investigation areas on SL-1 are: (1) Vehicle neutralization, (2) Beam plasma physics, and (3) Beam atmosphere interaction. In-beam (gun-mounted) measurements include beam current, electron density and temperature, and electric waves. Other measurements from the spacecraft include return currents vehicle charge, plasma density and temperature, electric and magnetic waves, video observations, and photometric measurments. Emphasis is on UV-Vis-IR measurements/observations.

TARGET DESCRIPTION: Look directions are established with respect to the geo- magnetic field vector. Zones of interest include: Auroral/high magnetic latitude (M.L. >60 deg), high and middle latitude (lat. > 30 deg), equatorial zone (M.L. < +- 2 deg), South Atlantic Anomaly (long. = 30 deg S +- 15 deg, lat. = 40 deg W +-30 deg), and ground radar sites.

SPECIAL REQUIREMENTS: Night operation desired (where sun is > 30 deg below the horizon on the ground) for those functional objectives relying on optical observations. Electron gun cathode is sensitive to O2, H2O, and micron size particles.

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REQID	SA2720
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	D. REASONER, MSFC
DERIVATION	SA2510/SA1310
FAMILY	PS/GE/I
MISSION/EXPERIMENT	WAVES IN SPACE PLASMAS (WISP)
ALTITUDE	325-500 (KM)
INCLINATION	50-90 DEG ~90 DEG PREFERRED
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	2.42 X 0.60 X 1.27 (M)
WEIGHT/MASS	00732 (KG)
AVERAGE POWER	01.0 (KW)
PEAK POWER	07.0 (KW)
DATA (I/O RATES)	7000.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN/> 1 DEG
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	01.0 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2720.TXT

WISP is facility for performing active (power radiating) radio frequency experiments. The major assemblies are the VLF Subsystem (VLFSS), HF Subsystem (HFSS), Dipole Antenna Subsystem (DASS), and the Comman Operating Research Equipment (CORE) assembly. VLFSS is a transmitter operating in the 1-30 kHz range. HFSS is a transmitter and receiver operating in the 100 kHz th 30 MHz range. DASS radiates outputs of the VLF and HF transmitters and receives the returned HF signals. CORE controls antenna extension/retraction, generates the VLF waveforms, and reformats returned HF signals for video display. The DASS mounting structure is treated as a GFE item. DASS mounting must provide high voltage/high frequency isolation. Cables from the HF and VLF transmitters carry high voltages (500-6500 V).

Major Deployable Elements/Internal Moving Parts: Antenna elements extend to 150 meters each in operating configuration. Tip-to-tip extension is 300 m. Antennas fit inside the triangular support elements when retracted. Spacelab WISP antenna elements extend to 50 m for 100 m tip-to-tip length. Cycle life is ~50 cycles. Extension/retraction takes ~4 min each direction. 100 m element length is considered achievable but costly.

Target Description: Magnetic field pointing. Field model provides field direction with 1-2 deg. uncertainty. Pointing error bands for most FO's are +-5-10 deg. Coordination with ground based receivers desired. See Notes for list. Scheduled for Spacelab-6.

REQID	SA2730
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	A.E. ROCHE, LMSC
DERIVATION	SA2520
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	CRYOGENIC LIMB ARRAY ETALON SPECTROMETER (CLAES)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	018 MONTHS
TECHNOLOGY DATE	
SIZE	2.6 X 1.2 dia (M)
WEIGHT/MASS	00450 (KG)
AVERAGE POWER	00.02 (KW)
PEAK POWER	
DATA (I/O RATES)	
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	18 MONTH HYDROGEN SUPPLY
THERMAL/CNTRL COND	PASSIVE (CRYOGENIC)
OPERAT ENVIRON	COOLED TO 10 DEG (K)
CONSUMABLES	20 (KG) (SOLID HYDROGEN)
TEXT	SA2730.TXT

CLAES is a cryogenically cooled (solid hydrogen) infrared spectrometer sensitive over 3.5-12 um range with 0.25 cm-1 resolution. Uses tilt-scanned solid etalons and blocking filters. The entire instrument is cooled, with the focal plane cooled to 10 K. Measures thermal limb emission. Specific interest in ozone destructive N and Cl families (N2O, NO, NO2, HNO3, CF2Cl2, CFCl3, HCl, ClO, and ClNO2), selected minor minor constituents (O3, H2O, CH4, and CO2), and temperature. One side viewing.

EMISSIONS/SUSCEPTIBILITIES: Sensitive to emission, adsorption, or scattering in the 3.5-12 um range. Deposition on optics degrades accuracy.

OPERATIONAL REQUIREMENTS: Global synoptic coverage desired. Operates both day and night. Limb scan is from 10-90 km altitude with a 90 second scan period.

REQID	SA2740
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	J. RUSSELL, LaRC
DERIVATION	SA2520
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	HALOGEN OCCULTATION EXPERIMENT (HALOE)
ALTITUDE	550 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	024 MONTHS (MINIMUM)
TECHNOLOGY DATE	
SIZE	0.70 X 0.76 X 0.82 (M)
WEIGHT/MASS	00096 (KG)
AVERAGE POWER	00.078 (KW)
PEAK POWER	00.096 (KW)
DATA (I/O RATES)	0004.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN/> 1 DEG
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	RAU/FMDM/SHUTTLE
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	0.078 (KW)
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2740.TXT

HALOE is an instrumentation concept developed for NIMBUS-G under the MAPS program. It has been selected for flight on the Earth Radiation Budget and Upper Atmosphere Research Satellites. No modifications have been identified for Space Platform flight.

HALOE measures the concentration of 9 atmospheric gases by gas filter correlation radiometry during solar occultation. Clear sun calibration observations are also required. Observations are desired at every sunrise and sunset. Observations are performed while the sunline is 10-60 km altitude at the tangent point. Clear sun observations require the sunline >150 km altitude at the tangent point. Typical observation duration is 7 minutes but varies with occultation position. Latitude/longitude coverage of the tangent point is needed over as wide a range as possible.

HALOE includes a two-axis gimbal with an azimuth range of +-180 deg. and elevation range of -9 deg to +26 deg. Glint free field of view required 30X30 degrees around sensor field of view. Sun sensor FOV is 20X20 degrees.

STS Interfaces: HALOE is launched with the isolation mount unlocked, but the mount must be locked for landing. Since the mount locks when the gimbal is rotated, STS power must be available during launch to lock the mount in the event of an abort.

REQID	SA2750
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	P. HAYS, UNIV. MICH.
DERIVATION	SA2520/SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	HIGH RESOLUTION DOPPLER IMAGER (HRDI)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	1.8 X 0.3 dia (M) "TELESCOPE"
WEIGHT/MASS	00076 (KG)
AVERAGE POWER	00.082 (KW)
PEAK POWER	
DATA (I/O RATES)	0004.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	PASSIVE
OPERAT ENVIRON	DAYLIGHT ONLY
CONSUMABLES	
TEXT	SA2750.TXT

HRDI is an imaging triple etalon Febry-Perot interferometer fed by a two axis gimbaled telescope. It observes adsorption features of O2 and bands in the scattered light in the 10-50 km attitude range and atmospheric emission features in the 60-300 km attitude range. Velocity broadening and doppler-shift measured. Both-side viewing desired. Desired wind measurement accuracy is 5 m/sec.

EMISSIONS/SUSCEPTIBILITIES: Sensitive to emission or adsorption in lines measured, and to deposition on optics.

OPERATIONAL REQUIREMENTS: HRDI operates in daylight only. Observations are made of the earth's limb at azimuth angles of 45 and 135 degrees with respect to the velocity vector. Measurement of one wind component requires one scan (20 sec), one side viewing. Measurement of two wind components requires two scans spaced 136 seconds apart, one side viewing.

REQID	SA2760
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	F. TAYLOR, OXFORD UNIV.
DERIVATION	SA2520
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	IMPROVED STRATOSPHERIC & MESOSPHERIC SOUNDER (ISAMS)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	TBD
TECHNOLOGY DATE	
SIZE	1.04 X 0.94 X 0.83 (M)
WEIGHT/MASS	00085 (KG)
AVERAGE POWER	00.125 (KW)
PEAK POWER	
DATA (I/O RATES)	0000.6 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	PASSIVE, (CC COOLED)
OPERAT ENVIRON	CLOSED CYCLE COOLED TO 70 DEG (K)
CONSUMABLES	
TEXT	SA2760.TXT

ISAMS is a limb scanning, infrared, gas correlation radiometer. Three of the detectors will be cooled to 70 K using closed cycle coolers. Specific sensitivity to $CO2$, $H2O$, CO, NO, $N2O$, and $CH4$. Measures thermal emission and resonance fluorescence of solar radiation. Instrument views cross track in both directions.

EMISSIONS/SUSCEPTIBILITIES: Gaseous contamination by species measured, or deposition on optics degrades accuracy.

OPERATIONAL REQUIREMENTS: Global coverage desired. Day and night operation. Scans limb from 15 to 60 km altitude with scan period of 36 seconds. One side views limb, other side simultaneously views space for calibration.

SPECIAL CONSIDERATIONS: Attitude knowledge to 0.0003 degrees desired to support a secondary objective (geopotential height measurement). To have all raw data transmitted to Oxford within 24 hours.

REQID	SA2770
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	J. WATERS, JPL
DERIVATION	SA2520
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	MICROWAVE LIMB SOUNDER (MLS)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	2.9 X 1.8 X 2.1 (M)
WEIGHT/MASS	00234 (KG)
AVERAGE POWER	00.47 (KW)
PEAK POWER	
DATA (I/O RATES)	0004.1 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	0036.0 (ARC SEC)
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	ACTIVE HEAT REJECTION
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2770.TXT

The instrument consists of a multi-frequency microwave radiometer operating at 63, 119, 183, 205, and 231 GHz. Specific interest is in thermal limb emission of O3, ClO, H2O2, O2, CO, and H2O to measure concentration, magnetic field, wind, temperature, and pressure. One side viewing.

EMISSIONS/SUSCEPTIBILITIES: Sensitive to microwave interference in observing bands.

OPERATIONAL REQUIREMENTS: Scans limb vertically from 15 to 100 km altitude. Scan period = 80 seconds. Operates both day and night.

REQID	SA2780
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	G.THUILLIER, SERV. d'AERO. du CNRS
DERIVATION	SA2520
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	TEMP AND WIND MEASUREMENTS IN THE MESOSPHERE & LOWER THERMOSPHERE (TWM)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	0.87 X 0.80 X 0.44 (M)
WEIGHT/MASS	00065 (KG)
AVERAGE POWER	00.047 (KW)
PEAK POWER	
DATA (I/O RATES)	0001.1 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	PASSIVE
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2780.TXT

The instrument is a wide angle Michelson interferometer fed by a Cassegrain telescope. Altitide scan performed by tilting a plane mirror. One side viewing selected natural emission lines are used to measure wind and temperature in high mesosphere and low thermosphere (5577 A-O(1S), 6300 A-O(1D), 7319 A-O+, and 7278 A, 7371 A-OH). Measurement objective is to derive the eddy diffusion coefficient. Desired measurement accuracies are +-3K in temperature and +-8 m/sec wind velocity.

EMISSIONS/SUSCEPTIBILITIES: Sensitive to emission or adsorbtion by oxygen (atomic or singly ionized) and hydroxyl (OH) at lines measured, and to deposition on optics.

OPERATIONAL REQUIREMENTS: The instrument scans the earth's limb from 80-300 km altitude in 28.5 sec. Observations are performed both day and night.

SPECIAL CONSIDERATIONS: Instrument temperature limits 273-313 k at all times due to molecular bonding of interferometer elements.

REQID	SA2790
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	G. ROTTMAN, UNIV COLORADO
DERIVATION	SA2520
FAMILY	PS/PH/I
MISSION/EXPERIMENT	ULTRAVIOLET SOLAR SPECTRAL IRRADIANCE EX (USSIE)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	0.61 X 0.17 X 0.20 (M)
WEIGHT/MASS	00008 (KG)
AVERAGE POWER	00.005 (KW)
PEAK POWER	
DATA (I/O RATES)	0000.064 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	DAYLIGHT ONLY
CONSUMABLES	
TEXT	SA2790.TXT

USSIE is a small Ebert-Fastie spectrometer mounted on a pointing platform capable of tracking both the sun and selected stars. Full disk spectral irradiance is measured in the region 115 to 440 nm. Selected ultraviolet stars are used to monitor calibration stability of the instrument.

EMISSIONS/SUSCEPTIBILITIES: Gaseous or particulate contamination that absorbs or scatters ultraviolet, or deposition on optics degrades accuracy of measurements.

OPERATIONAL REQUIREMENTS: Objective is to measure day to day variations in solar irradiance on the order of 1% over periods of the solar rotation. Want to observe sun at least daily. Stellar observations are needed periodically to monitor long term stability.

REQID	SA2800
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	B. ROBERTS, NASA HQ
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	SOFT X-RAY TELESCOPE (SX)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	2.7 X 1.0 dia (M)
WEIGHT/MASS	00465 (KG)
AVERAGE POWER	00.070 (KW)
PEAK POWER	00.105 (KW)
DATA (I/O RATES)	0400.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	0005.0 (ARC SEC)
MANNING	
INTERFACES	
SERVICE/MAINT	RESUPPLY GAS
LOGISTICS	FLIGHT DURATION GAS LIMITED
THERMAL/CNTRL COND	PASSIVE
OPERAT ENVIRON	SUN AVAILABLE
CONSUMABLES	GAS VENTED AT 1 LITER PER HR. "STP"
TEXT	SA2800.TXT

SX is a high resolution (1 arc sec) X-ray filter telescope supported by a fine field (20 arc sec) high resolution (^^/^ < 0.001) X-ray spectrometer. Mounting on a pointing system is assumed. The spectrometer contains three measurement channels, each with a collimator, a Bragg monochrometer, and a gas proportional detector. A two-axis gimbal system provides internal offset pointing for the spectrometer.

OPERATIONAL REQUIREMENTS: The operational objective is to observe/measure X-ray emissions from high temperature regions of the sun's atmosphere. X-ray video observations (1 frame each 10 sec) are made of the full disk to identify active regions. The spectrometer is offset pointed to observe the identified regions at selected wavelengths. Real time examination of images is desired for spectrometer pointing control. Near real time interaction on a 1-2 orbit basis is a workable mode.

SPECIAL CONSIDERATIONS: Photographic image recording was planned for the Spacelab version of SX. The two focal plane film cameras together contain 4000 exposures so film cameras may be meaningful in the context of a Space Platform mission provided environmental constraints can be met.

REQID	SA2810
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	B. ROBERTS, NASA HQ
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	LYMAN-ALPHA WHITE LIGHT CORONOGRAPH (WLC)
ALTITUDE	185+ (KM)
INCLINATION	ANY
ORBIT	
MISSION DURATION	NO FIRM LIMIT
TECHNOLOGY DATE	
SIZE	2.79 X 0.38 X 0.73 (M)
WEIGHT/MASS	00250 (KG)
AVERAGE POWER	00.087* (KW)
PEAK POWER	00.280 (KW)
DATA (I/O RATES)	0013.5 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0002.0 (ARC SEC)
POINTING ACC	0010.0 (ARC SEC)
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	PASSIVE
OPERAT ENVIRON	SUN AVAILABLE
CONSUMABLES	
TEXT	SA2810.TXT

The primary objective of this instrument is the measurement of coronal temperatures, densities, and flow velocities throughout the inner solar corona (1.2 Ro to 8 Ro from disk center). The single hardware unit contains a Spacelab Lyman-Alpha Coronograph (SLAC) and a White Light Coronograph (WLC) which make simultaneous and co-spatial observations. SLAC measures hydrogen Lyman-Alpha and O VI ^1032 radiations (0.04 - 5 A spectral resolution, 0.25 - 5 arc min spatial resolution). WLC measures intensity and polarization of visible coronal light (20 arc sec spatial resolution).

EMISSIONS/SUSCEPTIBILITIES: Instrument is sensitive to standard optical contaminants effective in the UV and visible spectrum.

OPERATIONAL REQUIREMENTS: This instrument requires sun center pointing, sun center pointing with an axial roll every 50 sec, and offset pointing by +-16 arc min. Mounting on an instrument pointing system is desired by the investigator to meet these requirements. Pointing knowledge desired within +-5 arc sec. Stability requirement is 2 arc sec for 30 sec.

SPECIAL CONSIDERATIONS: No spacecraft illuminated surfaces within 15 deg. of Solar LOS. Desire absolute time to +-100 msec, IPS pointing cooridinates, and time of sunrise and sunset.

*Includes 5 VA of 400 Hz ac power.

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REQID	SA2820
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	L. SIMMONS, JPL
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	ATMOSPHERIC TRACE MOLECULES OBSERVED BY SPECTROSCOPY (ATMOS)
ALTITUDE	400 (KM)
INCLINATION	
ORBIT	ANY/LEO
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	0.97 X 0.67 X 0.82 (M)
WEIGHT/MASS	00300 (KG)
AVERAGE POWER	00.175 dc, 00.135 ac (KW)
PEAK POWER	00.200 dc, 00.170 ac (KW)
DATA (I/O RATES)	16000.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0020.0 (ARC SEC)
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	RAU/FMDM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	0.333 (KW) COLD PLATE
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2820.TXT

ATMOS locks onto and tracks the sun near sunrise and sunset to measure the spectral adsorption of solar energy in the stratosphere. The primary measurement objectives are: (1) to identify trace species and measure the volume mixing ratios to levels of 10 to the -12th power; (2) to determine vertical profiles: and (3) to measure the stratospheric infrared background. The stratospheric zone of interest is from 20-80 km. Vertical resolution is 2 km. Typical observation lasts 3 minutes. Direct sun observations during orbit day and cold sky observations during orbit night are made for calibration.

With respect to electrical power ATMOS requires both 28 Vdc and 115 Vac power. ATMOS uses two HRM channels, one for science data at 15.76 Mbps and the other for engineering/housekeeping data at 1.28kbps. A cold plate is used for heat rejection.

Target Description: Sun is tracked during sunrise and sunset to measure adsorption spectrum of stratosphere between 20-80 km. Direct sun and cold sky observations are made for calibration purposes.

REQID	SA2830
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	D. DILLER, NASA HQ
DERIVATION	SA1310/SA1610
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	ERBE --- W-MFOV
ALTITUDE	600 (KM)
INCLINATION	46 DEG OR SS POLAR
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	0.67 X 0.25 X 0.24 (M)
WEIGHT/MASS	00030 (KG)
AVERAGE POWER	00.017 (KW)
PEAK POWER	
DATA (I/O RATES)	0000.24 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	PASSIVE
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2830.TXT

Sensors for the Earth Radiation Budget Experiment (ERBE) are contained in two instrument packages, a Wide and Medium Field of View (W/MFOV) unit, and a Scanner unit. The W/MFOV unit contains two nadir pointing sensors (FOV ~130 deg) viewing the entire Earth disk, two nadir pointing sensors (FOV ~75 deg) viewing a 10 deg Earth central angle, and a solar viewing cavity radiometer. This unit contains its own azimuth pointing gimbal.

EMISSIONS/SUSCEPTIBILITIES: ERBE W/MFOV measurement channels are 0.2-5 um and 0.2-50+ um. ERBE W/MFOV would be sensitive to contaminants effective within these spectral ranges.

OPERATIONAL REQUIREMENTS: Duty cycle of ERBE W/MFOV unit was not specified but continuous operation is anticipated. Data is averaged on a monthly basis. Monthly sampling of the solar flux density is desired. Earth viewing sensors (wire-wound thermopiles) view internally during launch and outgassing and view the sun, space and internal black-body sources for periodic in-flight calibration.

SPECIAL CONSIDERATIONS: ERBE objectives require simultaneous sampling of the radiation reflected from and emitted by the Earth. A minimum of two flight vehicles are needed, one in a 46 deg, 600 km orbit and the other in a high inclination orbit (polar mid-morning or mid-afternoon preferred).

REQID	SA2840
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	D. DILLER, NASA HQ
DERIVATION	SA1310/SA1610
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	ERBE ---- SCANNER INSTRUMENT
ALTITUDE	600 (KM)
INCLINATION	46 DEG OR SS POLAR
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	0.36 X 0.33 X 0.30 (M)
WEIGHT/MASS	00025 (KG)
AVERAGE POWER	00.035 (KW)
PEAK POWER	
DATA (I/O RATES)	0000.88 (KBPS)
DATA (STORAGE CAP)	
STABILITY	
POINTING ACC	
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	PASSIVE
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2840.TXT

The Scanner unit contains three boresighted sensors (3 deg FOV), mounts facing Earth nadir, and scans the sensors cross-track from horizon to horizon.

EMISSIONS/SUSCEPTIBILITIES: ERBE Scanner measurement channels are 0.2-5 um, 5-50 um, and 0.2-50 um. The ERBE Scanner would be sensitive to contaminants effective within these spectral ranges.

OPERATIONAL REQUIREMENTS: The duty cycle of the ERBE Scanner unit was not specified but continuous operation is anticipated. Data is averaged on a monthly basis. The continuously rotating scan drum sequences each sensor (pyroelectric type) through the Earth scan, a deep space view, and either a black-body view (long-wave and total bands) or a sun view (short wave and total bands).

SPECIAL CONSIDERATIONS: ERBE objectives require simultaneous sampling of the radiation reflected from and emitted by Earth. A minimum of two flight vehicles are needed, one in a 46 deg, 600 km orbit and the other in a high inclination orbit (polar mid-morning or mid-afternoon preferred).

REQID	SA2850
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	B. ROBERTS, MSFC
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	MAGNETOSPHERIC MULTIPROBES (MMP)
ALTITUDE	350+ (KM)
INCLINATION	57+ DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	3.9 X 1.4 X 1.5 (M)
WEIGHT/MASS	00846 (KG)
AVERAGE POWER	00.143 (KW)
PEAK POWER	
DATA (I/O RATES)	0060.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2850.TXT

MMP for Spacelab contains six free-flying instrument units which when released will provide spatially separated measurements of space plasma parameters. Space Platform MMP will contain 12 multiprobes. Each multiprobe will be stored in a spin-up/ejection canister prior to release. Other hardware remaining with the payload includes a transmitter, receiver, two antennas, and a command and data unit.

EMISSIONS/SUSCEPTIBILITIES: Data links from the multiprobes are in the 401-402 MHz rf band. Command links to the multiprobes are in the 137-138 MHz band. Each probe measures vector magnetic and electric fields, electron density and temperature, electron energy spectrum (5 eV - 25 keV), and electric field power spectrum (2 kHz - 10 MH).

OPERATIONAL REQUIREMENTS: Cooridination with SEPAC, WISP, AEPI, CRM, and RPDP is desired. Positioning of Space Platform and a multiprobe along a common magnetic field line is desired for some observations. Positioning with respect to Space Platform along velocity vector desired for other observations. Additional observations require auroral zone coverage. Desire attainment of latitude extremes (magnetic) between 2200 and 2400 local time.

SPECIAL CONSIDERATIONS: Antenna system needs a conducting surface and clear field of view (preferably 2pi steradians with respect to the mounting plane).

REQID	SA2860
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	B. ROBERTS, MSFC
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	LIGHT DETECTION AND RANGING FACILITY (LIDAR)
ALTITUDE	300 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	DEDICATED SP LAB PALLET
WEIGHT/MASS	01900 (KG)
AVERAGE POWER	03.5 (KW)
PEAK POWER	04.5 (KW)
DATA (I/O RATES)	0253.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	ACTIVE/PASSIVE
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2860.TXT

LIDAR is a modular multiuser facility consisting of several elements: (1) Laser sources - Nd: Yag, Dye system, CO2; detection packages: 1.25 meter class telescope; and controlling electronics. LIDAR will occupy a full pallet. Science objectives include profiling the abundance of atomic and molecular species and aerosols and collecting meteorological data (wind velocity, cloud height, temperature and pressure profiles). Pointing direction is mostly nadir.

EMISSIONS/SUSCEPTIBILITIES: Laser output is in the 0.2 - 12.0 um spectral range. LIDAR would be sensitive to the standard range of optical contaminants effective in this spectral range. Dye laser (215-940 nm) puts out 5 - 200 uJ pulses at a repetition rate of 10 Hz. CO2 laser puts out 10 J pulses at a 15 Hz repetition frequency.

OPERATIONAL REQUIREMENTS: Meaningful data may be taken over the 24-hour day. Some observations of particular target zones may be desired.

SPECIAL CONSIDERATIONS: Radiator requires view to space/sun avoidance.

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REQID	SA2870
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	B. ROBERTS, NASA HQ
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	ATMOSPHERIC X-RAY EMISSION TELESCOPE (AXET)
ALTITUDE	400 (KM)
INCLINATION	57 DEG
ORBIT	
MISSION DURATION	NO FIRM LIMIT
TECHNOLOGY DATE	
SIZE	1.02 X 0.79 X 0.21 (M)
WEIGHT/MASS	00210 (KG)
AVERAGE POWER	00.196* (KW)
PEAK POWER	00.294 (KW)
DATA (I/O RATES)	0010.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	PASSIVE
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2870.TXT

AXET will image and measure the spatial, temporal, and spectral distributions of X-ray aurorae produced by precipitating electrons in the Earth upper atmosphere (80-120 km). AXET detectors (proportional counters) provide source imaging from 5-25 keV and non-imaged data up to 50 keV. Instrument can detect 1 to 10 to the 5th power photons/cm2s (~10 keV) with an energy resolution of 20% FWHM. Spatial resolution is 200 km from a distance of 1500 km and temporal resolution is 1 sec for bright sources, 60 sec for dim sources. AXET consists of three detector units, one of Type A (10deg X 10deg FOV) and two of Type B (1deg X 10deg FOV).

EMISSIONS/SUSCEPTIBILITIES: RFI susceptibility. Broom magnets generate 500 Gauss field across collimators. Some venting of Xenon and CO2 is anticipated to purge counters.

OPERATIONAL REQUIREMENTS: The wide field of view detector will be used to search for active regions. The identified active regions will in turn be scanned (port rotation or single-axis pointer) by the narrow FOV detectors. Near real time data is desired for updating of the observing plan. Observations may be made day or night.

SPECIAL CONSIDERATIONS: On Spacelab the AXET units are mounted to look 18 deg below horizontal when the pallet is looking nadir.

*Includes 6 W of 28 Vdc and 190 VA of 400 Hz ac.

REQID	SA2880
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	R. ISE, MSFC
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	IMAGING SPECTROMETRIC OBSERVATORY (ISO)
ALTITUDE	250 (KM)
INCLINATION	ANY
ORBIT	
MISSION DURATION	NO LIMIT
TECHNOLOGY DATE	
SIZE	1.10 X 0.84 X 1.30 (M)
WEIGHT/MASS	00245 (KG)
AVERAGE POWER	00.190 (KW)
PEAK POWER	00.215 (KW)
DATA (I/O RATES)	2000.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	> 1 ARC MIN
POINTING ACC	> 1 ARC MIN
MANNING	
INTERFACES	RAU/HRM
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	0.19 (KW) COLD PLATE
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2880.TXT

The ISO instrument flying on SL-1 consists of an array of five spectrometers integrated as a pallet-mounted unit plus a rack-mounted control unit. The spectrometers provide 3-10 A resolution over the wavelength range 300-12000 A. Instrument is modular design so that gratings and detectors can be easily changed. Fewer than five modules can be flown if desired. Instrument could be mounted in IPS if desired.

ISO experiments measure the optical emissions from the Earth's atmosphere, the spacecraft induced atmosphere, artificially induced aurorae, and the interplanetary and interstellar media. ISO operates in a survey mode. Viewing opportunities/interests exist throughout each orbit. Typical viewing sequences last 20-30 min. SL-1 operations are planned on a two-shift basis, four personnel each shift. Nominal operation of the ISO experiment is accomplished by DEP software under the control of timelined commands.

Special Requirements: Physical alignment with horizon sensor desired within 2 degrees. Alignment knowledge desired within 1 arc min. ISO desires no illuminated object within 20 deg of FOV. Other requirements include sun >30 deg from FOV and moon >20 deg from FOV.

REQID	SA2890
SOURCE	SP82-MSFC-2583, 3-82
CONTACT/AUTHOR	
DERIVATION	SA1310
FAMILY	PS/GE/PH/I
MISSION/EXPERIMENT	ADVANCED LIMB SCANNER (ALS)
ALTITUDE	500 (KM)
INCLINATION	90 DEG
ORBIT	
MISSION DURATION	
TECHNOLOGY DATE	
SIZE	0.4 X 0.4 X 1.0 (M)
WEIGHT/MASS	00072 (KG)
AVERAGE POWER	00.165 (KW)
PEAK POWER	00.190 (KW)
DATA (I/O RATES)	0008.0 (KBPS)
DATA (STORAGE CAP)	
STABILITY	0036.0 (ARC SEC)
POINTING ACC	> 1 ARC MIN/> 1 DEG
MANNING	
INTERFACES	RAU/FMDM/HRM/PDI
SERVICE/MAINT	
LOGISTICS	
THERMAL/CNTRL COND	
OPERAT ENVIRON	
CONSUMABLES	
TEXT	SA2890.TXT

Target Description: Earth Limb. Internal scan mirror scans limb vertically. Scan mirror alternately scans opposite limbs. Clear space view required for calibration. Azimuth of scan not critical, but some preference for viewing limb in orbit plane.

Emissions/Susceptibilities: Sensitive to contamination affecting 6-18 um spectral range. Likely to be very sensitive to water vapor and CO2. ALS is looking at trace elements in upper atmosphere.

LMSC-D889718

SPACE STATION PROGRAMS

ATTACHMENT 2
SUPPORTING DATA AND ANALYSIS REPORTS
VOLUME I

SCENARIOS

Lockheed

SCENARIOS

Seventeen scenarios were initially identified as a means of combining space missions into an identifiable Space Station system. Requirements and concepts described in earlier volumes evolved from these scenarios and discussions with potential users pertaining to these scenarios.

A description of each scenario follows with the exception of two classified scenarios and the HEO Satellite Servicing. HEO Satellite Servicing is very similar to Satellite Servicing in LEO and is not included for that reason.

SCENARIOS

1. Human Research Laboratory
2. Non-Human Research Laboratory
3. Celestial Observatory
4. Space Environment Facility
5. Earth Observation Facility
6. Global Habitability Observatory Laboratory
7. Meteorological Facility
8. Material Processing Research Laboratory
9. Material Processing Facility
10. Space Observation Development Laboratory
11. Oceanography Observatory Development Laboratory
12. Orbiting National Command Post (Classified)
13. Space Objects Identification System (Classified)
14. On-Orbit Satellite Servicing in LEO
15. Large Satellite Assembly
16. On-Orbit Satellite Servicing in HEO
17. Space Platform Servicing - Free Flyer

U.S. NATIONAL SECURITY SCENARIO

SYSTEM/PROGRAM: Oceanographic Observatory Development Laboratory

Observations made during the first four Shuttle flights have demonstrated the benefit of correlating visual observations of the ocean by an astronaut in space with data obtained by various sensors (e.g., SAR antenna). We now recognize the need for an experimental laboratory in space in which multisensor systems (microwave, IR, lasers, etc.) can be developed and correlated with observations from space and on the ground to expand existing capabilities and our understanding of the data. Since the long-time behavior of ocean phenomena is of prime interest, long duration flights (30 to 60 day minimum) are required to accomplish this objective. Initial requirements are for the experimenter to control the pointing of the instruments. A desirable capability is to changeout or reconfigure equipment on orbit. Since the intent is to fly development or breadboard systems, equipment changeout goes beyond the usual approach to satellite servicing. Another objective is to reduce development costs to the range of aircraft sensor development cost and to reduce the development span by a factor of 2 or 3. A research objective is to evaluate the role of man in an operational environment (as opposed to developmental).

It is anticipated that sensors developed in a space station will lead to new or enhanced unmanned operational systems.

SYSTEM DESCRIPTION:

Lifetime: 3 to 6 months per experiment sequence
10-year useful operation

Launch Vehicle: Shuttle

Transfer Vehicle: None required for Space Station sortie missions
TMS required for cluster-free flyer

Operational Locations: Altitude, 300-700 km
Inclination, 60 deg preferred
300 km at 28.5 deg marginally useful

Total Mass at Operational Locations: TBD (but less than 14,000 kg)

Average Operational Power: TBD (but less than 5 kW)

Desired Initial Operational Date: 1988 (Shuttle-based experiments)
1990 (Space Station based experiments)

Oceanographic Observatory Development Laboratory (Continued)

General Needs:

- Equipment to be mounted on existing pallet (e.g., ESS or Spacelab pallet)
- Laboratory is to be capable of supporting experimental hardware and sensors
- Physical Characteristics: 9.1 x 4.3m diam.
  Up to 9.1m antenna (sortie)
  Up to 91m antenna (free flyer)
  - Operational Crew: 2 experimenters minimum (no equipment mods)
    10 technicians (maximum) for on-orbit equipment mods

CONTACTS

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Capt. W. Peirce	Dep. Director, Navy Space Pentagon
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Dr. R. Stevenson	ONR-West Scripps Oceanographic Institute La Jolla, California
Dr. Frank Allario	NASA-LaRC Hampton, Virginia

U.S. NATIONAL SECURITY SCENARIO

SYSTEM/PROGRAM: Space Observation Development Laboratory

Space surveillance opens a new spectrum of data which can be collected, evaluated, and utilized. Selection of the proper array of sensors and determination of optimum pointing for data acquisition can best be done from a space-based manned laboratory. Initial requirements are for the experimenter to control the pointing of instruments. A desirable capability is to changeout or reconfigure equipment on orbit. Since the intent is to fly development or breadboard systems, equipment changeout goes beyond the usual approach to satellite servicing. Another objective is to reduce development cost to the region of aircraft sensor development costs and to reduce the current development span from 6 to 8 years to 2 to 3 years.

It is anticipated that sensor development will lead to unmanned operational systems; however, a research objective is to evaluate the role of man in an operational environment (as opposed to developmental).

SYSTEM DESCRIPTION:

Purpose: Evaluate multisensor systems

Lifetime: 3 to 6 months per experiment sequence
10-year useful operation

Launch Vehicle: Shuttle

Transfer Vehicle: None required for Space Station sortie missions
TMS required for cluster-free flyer

Operational Locations: Altitude, 300-700 km
Inclination, 28.5 deg

Total Mass at Operational Locations: TBD (but less than 14,000 kg)

Average Operational Power: TBD (but less than 4 kW)

Desired Initial Operational Date: 1988 (Shuttle-based experiments)
1990 (Space Station based experiments)

GENERAL NEEDS:

- Equipment to be mounted on existing pallet (e.g., ESS or Spacelab pallet)
- Laboratory is to be capable of supporting experimental hardware and sensors

Space Observation Development Laboratory (Continued)

- o Physical Characteristics: 9.1m x 4.3m diam.
  Up to 9.1m antenna (sortie)
  Up to 91m antenna (free-flyer)

- o Operational Crew: 2 experimenters minimum (no equipment mods)
  10 technicians (if on-orbit equipment mods are to be made)

CONTACTS:

Col. J. B. Gross	Hq. USAF/INET Pentagon
Col. R. A. Schow	ASPO Alexandria, Virginia
Capt. W. Pierce	Dep. Director, Navy Space Pentagon
RADM. W. E. Ramsey	Director, Navy Space Pentagon
Dr. Frank Allario	NASA-LaRC Hampton, Virginia

GLOBAL HABITABILITY ASSESSMENT SCENARIO

SYSTEM/PROGRAM: Global Habitability Observatory Laboratory

The Woods Hole, Massachusetts, Workshop, June 21-26, 1982, has identified the urgent need to understand and control factors that relate to the production of food to meet the needs of the growing Earth population. Pertinent to this is the need to understand interactions between land, ocean, and atmosphere that affect the ability of the Earth to sustain human and animal habitation. In this century, humanity has become a key factor in the global environmental cycles of carbon, nitrogen, phosphorus, and sulphur that can affect global and regional air quality and climate. An understanding of the overall system is essential for the survival of the human race.

A long-duration space observatory that can use specialized sensing instruments and manned presence for realtime observation and evaluation can provide the means to assess global habitability effects of the sun, depletion of ozone by freon. It is anticipated that initially the laboratory will be used to develop sensor equipment, sensing techniques, and to verify man-machine interactions that affect sensing and control measures. Once operational, the space facility can be used to maintain a continuous assessment of changes in the Earth environment.

SYSTEM DESCRIPTION:

Purpose: To monitor changes to the Earth environment and assess impacts on habitability

Lifetime: 10-year useful operation

Launch Vehicle: None required if attached to Space Station
TMS required for free-flyer platform

Operational Location: Altitude, 300 km
Inclination, 57 deg preferred

Total Mass at Operational Locations: TBD (but less than 14,000 kg)

Average Operational Power: TBD (but less than 7 kW)

Desired Initial Operational Date: 1990

GENERAL NEEDS:

- Equipment to be mounted on existing pallets (Spacelab type)
- Laboratory to be capable of supporting both experimental hardware and sensors as well as operational equipment

Earth Habitability Observatory Laboratory (Continued)

- o Capable of continuous operation
- o Onboard data storage, programming, and analysis capability; provisions for preprogrammed and realtime targeting
- o Physical characteristics: 9.1m x 4.3m (diam)
- o Operational Crew: 4-6 technicians

<u>CONTACTS</u>:

ASTROPHYSICS SCENARIO

SYSTEM/PROGRAM: Celestial Observatory

The objective of this mission is to use the STARLAB, a 1m, ultraviolet/visible, wide-field telescope coupled with a direct imager and a spectrograph to observe celestial sources. Wavelengths from UV to visible range (120-20,000 nm) are surveyed in continuous time intervals from 2 to 45 min. A planned objective is to achieve 2/3 of total time productive. Scientific investigations that can be conducted include high-resolution, wide-field imaging, far ultraviolet spectroscopy, precise spectrophotometry and polarimetry, and synoptic planetary observations. A Starlab mission can have unique scientific objectives and an appropriate instrument complement.

SYSTEM DESCRIPTION:

Purpose: To observe, catalog, and evaluate light sources from the celestial sphere (galactic, extragalactic, solar system) on a continuous basis

Lifetime: 10 years (1989-1990 launch)

Launch and Transfer Vehicles: Shuttle/teleoperator maneuvering system (TMS)

Operational Locations: Altitude, 300-400 km
Inclination, 28.5 deg

Total Mass at Operational Location: 3280 kg

Average Operational Power: 1.4 kW; peak power 5 kW

Physical Characteristics: Telescope instrument, 1.5m diam., 5 m long

Pointing Accuracy: 10 to 30 arcsec

GENERAL NEEDS:

- Observation equipment to be mounted on pallet/platform
- Observatory capable of continuous operation (2/3 of total time to be productive)
- Capability to preprogram viewing and to interact in realtime to verify target acquisition

Celestial Observatory (Continued)

- o Orbit to minimize atmospheric ultraviolet absorption and radiation from Van Allen belt
- o Pointing system to improve target availability, provide rapid retargeting, and high pointing accuracy and stability; slew rate of 180 deg in 5 min is desired
- o Contamination control measures are needed to eliminate gases or particles that absorb, scatter, or emit ultraviolet radiation and any materials that can condense on optics
- o Observatory requires accurate tracking data and capability to correlate celestial targets and observatory track
- o Secondary mirror for focus control and image motion compensation
- o Data recording and storage
- o Command and data handling computer
- o Digital data transmission via TDRSS (Tracking and Data Relay Satellite System)
- o Platform provided attitude control and general celestial pointing, power, and thermal control

SYSTEM CONFIGURATION:

The Starlab facility consists of a 1m-aperture, f/15 modified Richey-Chretien telescope, followed by instrument selector, that gives access either to the conventional Cassegrain focus or to a radial focal plane. Starlab will consist of two major sections, the telescope and the instrument bay, which are joined at a central structural ring. The complete Starlab is attached to the stop plate of an instrument pointing system provided by the European Space Agency.

The complement of focal plane instruments may be changed and can be tailored to meet specific scientific objectives. Each focal plane instrument and its observation program may be selected automatically once the target is acquired. Control of the instrument may be managed interactively by the payload specialist. Data-taking sequences for Starlab instruments will range from seconds to hours on each object. The acquisition of scientific data from Starlab can be in the form of film and telemetry data. Digital data can be multiplexed into the Space Station data management system and transmitted through the TDRSS for recording.

Celestial Observatory (Continued)

CRITICAL TECHNOLOGY NEEDS:

Current technology is satisfactory. Potential improvements can be used in the following:

- o Direct imaging camera detector
- o Large format detector
- o Two-dimensional photon-counting devices

INSTRUMENT ELEMENTS:

- o Direct imaging camera
- o Planetary imaging camera
- o Precisely calibrated spectrophotometer
- o Far UV spectrograph
- o High-resolution spectrometer

CONTACTS:

SPACE ENVIRONMENT SCENARIO

SYSTEM/PROGRAM: Space Environment Facility

Monitoring the environment of space and determining the radiation characteristics and seasonal variations as a function of extended time periods will be primary scientific goals to support space programs during the 1990s. A Solar Terrestial Observatory (STO) containing 17 flight experiments has been identified by NASA MSFC as a potential for the SASP. The STO objectives include the following environmental areas: solar variability, wave-particle processes, magnetosphere-mass transport, global electric circuit, upper atmospheric dynamics, middle atmosphere chemistry and energetics, lower atmospheric turbidity, and planetary atmospheric waves. Investigations in these areas require extensive simultaneous and continuous operation of STO instruments.

SYSTEM DESCRIPTION:

Purpose: To measure environmental characteristics of space on a continuous and long-duration basis

Lifetime: 10 years

Launch and Transfer Vehicle: Shuttle

Operational Locations: Altitude, 400 km
Inclination, 57 deg preferred

Total Mass at Operational Locations: 15,000 kg

Average Operational Power: TBD (but less than 10 kW)

Desired Initial Operational Date: 1990

General Needs:

- o Equipment to be mounted on 4 pallets (similar to Spacelab)
- o Observatory capable of continuous operation
- o Capability to preprogram viewing of some instruments

Space Environment Facility (Continued)

- o Contamination control measures are needed. Instruments are sensitive to H_2O, CO_2, and optical contaminants effective in the IR-visible-UV spectral regions. STO emits particle beams (electrons, He, and Ar) RF radiation (1-30 kHz, 0.130 MHz, and 400 MHz) laser light (IR-UV) and purge gases (Xe, CH_4 and CO_2)
- o Viewing requirements include solar, limb, limb through solar occultation, nadir and magnetic field pointing
- o Physical Characteristics: 4 pallet grouping
  7.6m x 4.3m diam. (X axis)
  3.0m x 4.3m diam. (+ Y axis)
  3.0m x 4.3m diam. (- Y axis)
- o Operation Crew: TBD

SYSTEM CONFIGURATION:

The STO consists of the 17 experiments as summarized in the following table.

CONTACTS:

SUMMARY OF CHARACTERISTICS AND REQUIREMENTS FOR STO INSTRUMENTS

SP PORT		INSTRUMENT	ACRONYM	WEIGHT (kg)	& PALLET AREA	POWER (W) OP./PEAK	THERMAL CONTROL	DATA (kbps) LR/HR	OPERATION	POINTING ACCOM.
+Y	1	TOTAL IRRADIANCE MONITOR	ACR	20	5	10/13	Cold plate	0.217/NA	Sun Av.	Fixed
	2	IRRADIANCE MONITOR	SUSIM	84	<10	123/153	Passive	0.531/NA	Sun Av.	Fixed
	3	SOFT X-RAY TELESCOPE	SX	465	25	70/105	Passive	TBD/3.8 + 400	Sun Av.	AGS
	4	WHITE LIGHT CORONAGRAPH RESONANCE LINE CORONAGRAPH	LYMAN ALPHA	250	25	87/280	Passive	TBD/13.5	Sun Av.	AGS
	5	IR ABSORPTION SPECTROMETER IR EMMISION SPECTROMETER	ATMOS-P	300	15	310/370	Cold Plate	NA/1.28 15,760	Sunset/rise	Built in
	6	RADIATION BALANCE MONITOR	ERBE	55	5	52/60	Passive	1.120/NA	Cont.	Built in
−Y	7	PARTICLE INJECTOR	SEPAC	637	25	1000/3000	Cold plates	1.4/512 + TV + WB An.	High Mass, Lat., Night	Built in
	8	MULTIPROBES	MMP	1692	<50	143/143	Passive	TBD/60	Cont.	--
+X	9	LIDAR	LIDAR	1900	100	3500/4500	Cold plates	TBD/253	Intermit.	Body Ptg.
	10	LOW LIGHT LEVEL TELEVISION	AEPI	174	<10	340/560	Cold Plate	1.0/277 + TV	SEPAC/WISP	MAST
	11	X-RAY TELESCOPE (AXET)	MX	210	<10	196/294	Passive	TBD/~10	Cont.	Fixed
	6	RADIATION BALANCE MONITOR	ERBE	55	5	52/60	Passive	1.120/NA	Cont.	Built in
	12	VISIBLE SPECTROMETER	ISO	245	<15	190/215	Cold Plate	0.001/125 or 2000	Day/Night	Built in
	13	UPPER ATMOSPHERIC TEMPERATURE SOUNDER	ALS	72	<10	165/190	Cold Plate	TBD/8	Cont.	Fixed
	14	UPPER ATMOSPHERIC WIND SENSOR	HRDI	76	<10	82/150	Passive	TBD/4	Day	Built in
	15	WISP	WISP	732	<50	1000/7000	Cold plates	TBD/7000	Day/Night	Body Ptg.
FREEFLYERS SEPARATE LAUNCH	16	CHEMICAL RELEASE MODULE	CRM	1900	100	NO STO-ATTACHED HARDWARE				
	17	RECOVERABLE PLASMA DIAGNOSTIC PACKAGE	RPDP	440	<40	50/50	Cold plate	0.296/32 + 1200	Cont.	--

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EARTH OBSERVATION SCENARIO

SYSTEM/PROGRAM: Earth Observation Facility

Observation of Earth on a continuous long-term basis will continue to be a key method in allowing man to understand and survive in his environment. Detection and monitoring of geodetic characteristics, thermal absorption and radiation characteristics, and status of renewable and nonrenewable material resources will be important functions that will allow man to understand and plan for survival.

The state of the art for sensors has permitted unmanned operational systems to date; a research and developmental objective of this program is to evaluate the role of man in an operational environment and to evaluate the effectiveness of new sensing and analysis techniques.

SYSTEM DESCRIPTION:

Lifetime: 5 to 10 years

Launch Vehicle: Shuttle

Transfer Vehicle: None required for Space Station attached mission. Teleoperator maneuvering system (TMS) required for detached (cluster-free flyer missions)

Operational Locations: Altitude, 400-600 km
Inclination, 57 deg preferred
Inclination, 28.5 deg marginally useful

Total Mass at Operational Locations: TBD (but less than 5,000 kg)

Average Operational Power: TBD (but less than 6 kW)

Desired Initial Operational Date: 1990 (Space Station supported)

General Needs:

- o Sensors and equipment to be mounted on existing pallet-type structures (e.g., Spacelab pallet)
- o Facility capable of continuous operation
- o Capability to preprogram viewing and to interact in realtime to verify specific target areas; quick-look capability

Earth Observation Facility (Continued)

- o Facility requires accurate track data and capability to correlate target locations on Earth's surface
- o Physical Characteristics: 7.6m x 4.3m diam.
  10.6m antenna for SAR-type imaging sensor
- o Operational Crew: Capability for temporary manned habitation
  2 experimenters
- o Realtime data transmission to control observation station (ground - space)
- o Computer preprocess capability

SYSTEM CONFIGURATION:

The facility will use a synthetic aperture radar (SAR) with L- and C-band and L- and X-band capability. A planar phased array antenna (11m x 2.1m) is used in conjunction with the radar electronic and data electronics. Electronic beam steering and mechanical tilting of antenna is used to acquire targets.

The facility will also use an imaging spectrometer (IS) fed by a 3m telescope mounted on a pointing mount for fine guidance and pointing.

CONTACTS:

Geology

M. Duke	NASA JSC

Land Cover/Land Use/Productivity

R. Hill	NASA JSC

Agricultural

C. Caudill	USDA
R. Gilbert	USDA/SCS
R. Hatch	USDA AGRISTARS
R. McArdle	WORLD FOOD BOARD

Natural Vegetation Inventory/Monitoring

R. Alison	USFS
S. Green	DEA

Earth Observation Facility (Continued)

Environmental Observations
Near Atmosphere

M. Helfort	NOAA

Oceans, Coastal and Estuarine

J. Koltenback	NASA JSC

General

J. Erickson	NASA HQ
J. Knull	Space & Technology - Washington, D.C.
W. Huffstetler	NASA JSC
W. Piotrowski	NASA HQ

MATERIAL PROCESSING SCENARIO

SYSTEM/PROGRAM: Material Processing Research Laboratory

Material research experiments performed under changing environments, including KC-135, Skylab, and Shuttle flights, have demonstrated possible benefits to be gained from certain processing methods under microgravity conditions.

It is probable that man can increase the efficiency of research in space as he does on ground based laboratories.

A desirable capability is to be able to perform a variety of experiments and to be able to duplicate them without a roundtrip to Earth. The intent here is to resolve the many unanswered questions as to material behavior under microgravity conditions. Another objective is to reduce the time required to go from idea to production.

It is anticipated that findings from this material processing laboratory will find their way into processes on Earth, but also may result in free-flying automated facilities serviced by a manned space station.

SYSTEM DESCRIPTION:

Purpose: To conduct research on materials processes to develop and conduct proof of principal experiments

Lifetime: 3 to 6 years

Launch Vehicle: Shuttle

Transfer Vehicle: Shuttle

Operational Locations: Any Earth orbit; for radiation reasons, the lower range of inclination angles and altitudes are preferred.

Total Mass at Operational Locations: 15,000 kg

Average Operational Power: 5 kW to 10 kW maximum

Desired Initial Operational Date: 1990

General Needs:

- o Experiment to be based in a shirtsleeve laboratory
- o General type laboratory benches equipped with electrical plug-ins, gaslines, hotplates, coldplates, etc.

Material Processing Research Laboratory (Continued)

- General type analytical and electrical instruments, permanently installed. Such instruments will will include microscopes, gas chromatagraphs, mass determinators, centrifuges, scanning electron microscope, optical and mass spectrographs.
- Experiment section should be separable (fire door) from the general lab section
- Capability data record, display and storage/recall of data
- On-board computer controlled collection, storage and analysis capability
- Communications via TDRSS
- Physical Characteristics: 10.5m x 4.3m diam
- Resupply: 3 months for personnel changes
3 - 6 months for consumables
- Operational Crew: 2 - 4 lab operators

<u>CONTACTS</u>:

SPACE MANUFACTURING SCENARIO

SYSTEM/PROGRAM: Material Processing Facilities

The objective of this mission is to use the unique space enivronment for commercial production of materials such as metals, semiconductors, polymers, ceramics, pharmaceuticals, and improved microbiological processes such as fermentations and genetic engineering. The processes to be performed here are those developed in the Material Research Laboratory. Also results from the MPS ground based research program will be incorporated.

Before the construction of a production facility is contemplated, it is necessary to conduct evaluation tests on prototype or pilot models. Data from such prototype models generate operational and economic data necessary for feasibility decisions. Therefore, two types of facilities are proposed for this scenario:

- o Materials Processing R&D Facility (1990)
- o Materials Processing Operations Facility (1995)

Description of these facilities follows.

Materials Processing R&D Facility System Description:

Purpose:	To allow for assembly, modification, and testing of prototype or pilot models of production facilities
Lifetime:	3 to 6 years
Launch Vehicle:	Shuttle
Transfer Vehicle:	Shuttle
Operational Locations:	Any Earth orbit at low radiation levels
Total Mass at Operational Level:	15,000 kg
Average Operational Power:	10 kW

Material Processing Facilities (Continued)

GENERAL NEEDS:

- o Shirtsleeve environment but with ready access to space for both men and equipment. Small models will be put in free-flyer (low g) mode for tests. Shielding to avoid cross- and station contamination therefore must be provided for.
- o Provision for general tool, machine, and electrical shops.
- o Supplies such as gases for welding, oils for lubrication, cleaning solvents.
- o Capability for data record, display, and storage/recall of data.
- o Onboard computer controlled collection, storage, and analysis capability.
- o Microbiological cpabilities.
- o Physical Characteristics: 15.2m x 4.3m (diam.)
- o Resupply: 3-6 month for commercial supplies.
- o Operational Crew: As required for repair and maintenance.
- o Need for g levels to be $<$ 10-5 for long periods (up to 1 month)

MATERIAL PROCESSING OPERATIONS FACILITY SYSTEM DESCRIPTION:

Purpose: To commercially process materials needing the unique space environment (microgravity) to be able to improve yield or precision.

This facility will not have permanent manned habitation, but instead will be able to support a man for short periods of time (2 days). Because of the nature of the work to be performed and the possible environmental contamination, this facility will be proposed as a free flyer to be tended by the space station.

Material Processing Facilities (Continued)

Lifetime: 5 to 10 years

Launch Vehicle: Shuttle

Transfer Vehicle: Facility to Space Station (for Free Flyer mode)

Operational Locations: Any Earth orbit at low radiation levels

Total Mass at Operational Locations: 25,000 kg

Physical Characteristics: 15m x 4.3m diam.

Average Operational Power: 15 kW

Desired Initial Operational Date: 1995

GENERAL NEEDS:

- Shirtsleeve environment
- Capability data record, display and storage/recall of data
- Onboard computer controlled collection, storage, and analysis capability
- Communications via Space Station to TDRSS
- Microbiological capability
- Facility and its processes controlled by Space Station
- Facility not physically connected to Space Station
- Resupply: Every week - personnel from Space Station
  3-6 months for commercial supplies
- Operational Crew: As required for repair and maintenance of free-flying facility

CONTACTS:

LIFE SCIENCES SCENARIO

SYSTEM/PROGRAM: Non-Human Research Laboratory

The objectives of this mission are to (1) provide data and verification of research findings to support qualification of man for indefinite exposure to weightlessness, (2) further understand zero-gravity biology in the areas of plant, bacteria, and animal development and, (3) conduct research in Controlled Ecological Life Support System (CELSS).

SYSTEM DESCRIPTION:

Purpose: To perform invasive or prolonged research on non-human specimens to further the understanding of biological effects of space

Lifetime: 10 years

Launch and Transfer Vehicle: Shuttle

Operational Locations: Low-earth orbit such as 28.5 deg except for radiation studies that will require either a higher inclination or altitude

Total Mass at Operational Locations: Approximately 10,000 kg

Average Operational Power: Approximately 8 kW

Desired Initial Operational Date: 1990

GENERAL NEEDS:

- A laboratory separate from the human research facility containing vivaria for animals and plants. The vivaria must provide air, water, food, and waste management to keep the animals and plants healthy and stable. The laboratory must also provide suitable work areas and facilities and instrumentation such as sampling and analysis equipment and surgical capabilities to conduct required experiments.
- Physical Characteristics: 7.6 x 4.3 m diam (equivalent to a full Spacelab module)
- Resupply: 3 to 6 months for specimen change

Non-Human Research Laboratory (Continued)

ARCHITECTURE/CONFIGURATION CONSIDERATIONS:

The non-human research laboratory will be a separate laboratory isolated from the habitability module. It will involve specimen holding facilities for animals and plants. These holding facilities will be similar in nature to those being developed for Spacelab; however, they may have a higher level of automation to reduce crew time required to service the facilities. The other supporting equipment such as laminar flow workbenches and other laboratory instruments will probably be very similar to those being developed for Spacelab life sciences laboratories. A variable gravity centrifuge will also be required for experiment controls and subgravity research. The centrifuge must provide the same levels of life support as the holding facilities. Any experiments involving unique species will require experiment specific life support provisions.

The non-human laboratory will also include equipment required to evaluate biological life support system development for future long-duration missions.

Most of the life sciences experiments require crew manipulation; therefore, the primary non-human laboratory must be attached to the Space Station with crew members transferring from the habitability module to the non-human life sciences laboratory in a shirtsleeve environment. A number of experiment types such as radiation, biology, or plant biology require no in-flight manipulation and hence these could be located on a free-flyer.

CRITICAL TECHNOLOGY NEEDS:

- o Upgrading of holding facilities and support hardware to provide higher levels of automation than are planned for Spacelab missions
- o Increasing life support capacity of holding facilities
- o Development or onboard analysis capabilities.

EXPERIMENTS AND FACILITIES:

Experiments: (see Table 1)

Common Facilities: (see Table 2)

Non-Human Research Laboratory (Continued)

CONTACTS:

A large number of persons were contacted to review and discuss the Non-Human Life Sciences Research Facility. Significant contributors included:

Joe Sharp	Deputy Director, Life Sciences, NASA-ARC
Dick Johnson	Chief, Biosystems Division
Bill Berry	Chief, Life Sciences Experiments Project Office
Hal Sandler	Chief, Biomedical Research Branch

TABLE 1 - NON-HUMAN LIFE SCIENCES EXPERIMENTS

GENERAL PARAMETERS: Orbit altitude - Below Radiation Belt; Inclination - Nonpolar
Synchornization - None; Pointing and View direction - N/A; Environment - Shirtsleeve

Experiments	Discipline				Species (No. Required)														Duration		Degree of Required Manned Intervention			Priority						Data Requirements		
Identified by NASA Headquarters	ANIMAL PHYSIOLOGY	PLANT PHYSIOLOGY	CELL DEVELOPMENT	BIO-ENGINEERING	RAT	MOUSE	SQUIRREL MONKEY	RHESUS MONKEY	FROG	CAT	BIRD	FISH	FROG EGGS	MOUSE EMBRYO	PLANTS	MICROBE CULTURES	CHICKEN EGGS	INSECTS	Long as Possible	Discrete	NONE CATEGORY I	PERIODIC CATEGORY II	CONTINUOUS CATEGORY III	SOLVES LONG-TERM HUMAN SPACE BIOMEDICAL PROBLEM	SOLVES SHORT-TERM CREW EFF. PROBLEM (NATIONAL SECURITY)	CONTRIBUTES TO ADV. LIFE SUPPORT OR HEALTH MAINTENANCE SYSTEMS	USES SPACE TO BETTER UNDERSTAND BIOMEDICAL PROBLEMS ON EARTH	POTENTIAL FOR NON-NASA HARDWARE SPINOFF	INCREASES UNDERSTANDING OF ORIGIN EVOLUTION, DISTRIBUTION OF LIFE IN UNIVERSE	ONBOARD	DOWNLINK	Experiment Unique Hardware/Requirements
1. CALCIUM HEMATOSIS	X				42		42 ALT												X			X		X			X	X		None	X	None
2. MUSCLE FUNCTION	X				42		42 ALT												X			X		X		X				None	X	None
3. FLUIDS/ELECTROLYTES	X				6		6 ALT												X				X	X	X	X	X			None	X	None
4. METABOLISM	X				12		12 ALT												X			X				X	X			X	X	None
5. VESTIBULAR PHYSIOLOGY	X				24														X			X		X			X			None	X	None
6. VESTIBULAR MECHANISM	X				8 ALT		4*	4 ALT	8 ALT	4 ALT	8 ALT	8 ALT							X				X		X	X	X	X		X X	X X	Stereotaxic/Microelectrode Special Holding Facility
7. ANIMAL REPRODUCTION	X		X		12*													X	X				X	X			X		X	None	X	None
8. RADIATION BIOLOGY (180 DAYS)	X					100												X	X		X			X	X				X	None	X	Shielded Cages, High Inclination/Altitude Orbit
9. RADIATION BIOLOGY (2 YEARS)	X					100													X		X			X		X		X	X	None	X	Shielded Cages, High Inclination/Altitude Orbit
10. CARDIOVASCULAR	X							4												X		X		X		X	X	X		None	X	Rhesus Monkey Restraint
11. ANIMAL DEVELOPMENT (INFANT)	X		X			140						X								X			X	X			X		X	X	X	None
12. ANIMAL DEVELOPMENT (EGGS)	X		X			20							120 ALT	20 ALT			120 ALT			X			X				X		X	None	X	None
13. PLANT DEVELOPMENT		X	X												X					X	X					X	X			None	X	None
14. PLANT PHYSIOLOGY		X	X												X					X	X					X	X			X	X	None
15. CELSS (Seedlings)		X		X											X					X	X					X	X			None	X	None
16. CELSS (Plants)		X		X											X					X			X			X	X			X	X	Water Analyzer, Purification System
17. CELSS (Cells)		X		X												X				X	X					X	X		X	X	X	Aeration System, Automatic Cell Counter
OTHER EXPERIMENTS																																
18. BODY MASS LOSS	X							4											X				X	X		X	X			None		None
19. BIORHYTHMS	X					8	4	2 ALT											X		X			X			X			X	X	None
20. BEHAVIOR PERFORMANCE	X						4	2 ALT											X				X	X	X	X	X	X		X	X	None
21. CELLULAR & TISSUE REPRODUCTION & GROWTH	X				4	8 ALT			8 ALT										X		X					X	X		X	None	X	None
22. IMMUNOLOGY HEMATOLOGY	X				4*		4* ALT	4* ALT											X				X	X		X	X			None	X	None
23. NEUROPHYSIOLOGY	X				4*		2* ALT	2* ALT	4* ALT	4* ALT									X				X	X		X	X	X		X	X	None
24. ACCEL. IMPACT PHYSIO.	X				4*														X				X	X			X	X		X		None
25. PLANT GEOTROPISM		X													X					X	X						X			None		None

*Specimens that cannot be shared.

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TABLE 2 - NON-HUMAN LIFE SCIENCES EXPERIMENTS COMMON FACILITIES

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HARDWARE REQUIREMENTS	REQUIRED BY EXPERIMENT NUMBER	DEVELOPMENT STATUS	WEIGHT (kg)	VOLUME (cu m)	POWER (W)	HUMAN USE ALSO
ANIMAL HLDG FAC (RODENT) (A005-1)	1-9, 11, 12, 21, 23, 24	FABRICATION	280	1	320	
ANIMAL HLDG FAC (SML PRI) (A005-2)	1-9, 11, 12, 19, 20, 22-24	FABRICATION	240	1	320	
ANIMAL HLDG FAC (LARGE PRIMATE)	10, 19, 20, 22, 23	CONCEPTUAL	200	2	300	
GENERAL PURPOSE WORK STATION (A004)	1-7, 11, 12, 14, 16, 23	DESIGN	325	2	500	
SMALL MASS MEASUREMENT (J006)	1-7, 11, 12, 18	COMPLETE	17	0.04	15	X
BIOTELEMETRY SYSTEMS (A010)	6, 10, 19	FABRICATION	36	0.026	NIL	
DISSECTION MICROSCOPE (A006)	1-3, 5, 11, 12, 14, 21	DESIGN	18	0.1	60	
RADIATION DOSIMETER (A017)	8, 9	DESIGN	3.9	0.006	14	
VARIABLE GRAVITY CENTRIFUGE	1, 2, 4, 7, 12, 14, 19	CONCEPTUAL	830	3	1100	
VESTIBULAR RESEARCH FACILITY	6, 23	CONCEPTUAL	830	3	2300	
LINEAR SLED	6, 23	CONCEPTUAL	260	7	TBD	
FREEZER (-30°C) (J044)	1-5, 7, 11, 12, 16	DESIGN	70	0.3	200	
INCUBATOR	17, 12	CONCEPTUAL	36	0.13	80	
RACK MOUNTED CENTRIFUGE (J003)	1, 2, 3, 11, 12, 22	COMPLETE	30	0.08	TBD	X
GAS ANALYZER (J007)	4, 16	COMPLETE	41	0.1	150	X
BLOOD COLLECTION SYSTEM (J005)	1, 2, 3, 11, 12, 22	COMPLETE	8	0.05	NONE	X
PLANT HOLDING FACILITY (SMALL) (PGU)	13-16	COMPLETE	18	0.01	75	
PLANT HOLDING FACILITY (LARGE)	13-16	CONCEPTUAL	200	1	300	

TABLE 2 - NON-HUMAN LIFE SCIENCES EXPERIMENTS COMMON FACILITIES
(Continued)

Page 6

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HARDWARE REQUIREMENTS	REQUIRED BY EXPERIMENT NUMBER	DEVELOPMENT STATUS	WEIGHT (kg)	VOLUME (cu m)	POWER (W)	HUMAN USE ALSO
METABOLIC CAGE MODULE (RAHF)	3, 4, 21	CONCEPTUAL	2	0.005	2	
NESTING CAGE	7, 11, 12	CONCEPTUAL	2	0.005	NONE	
VIDEO RECORDER	7, 14	DESIGN	11	0.013	14	
ANIMAL SACRIFICING KIT	1, 2, 3, 5, 7, 11, 12, 23	COMPLETE	7	0.001	10	
DISSECTION KIT	1, 2, 3, 5	COMPLETE	2	NIL	NONE	
MINI OSCILLOSCOPE (J001)	19, 23, 24	COMPLETE	1.9	0.003	BATTERY	X
MICRO COMPUTER (J002)	23	COMPLETE	10	0.03	8	X
MULTI-CHANNEL STRIP RECORDER (J018)	23	CONCEPTUAL	30	0.09	500	X
CASSETTE DATA RECORDER (J045)	19, 23, 24	COMPLETE	NIL	NIL	BATTERY	X
EVENT TIMER (J047)	23	COMPLETE	0.2	NIL	BATTERY	X
EMG MONITOR AND SIGNAL CONDITIONER	18, 24	COMPLETE	0.06	NIL	BATTERY	X
GEOSTAT/CLINOSTAT	25	CONCEPTUAL	TBD	0.1	TBD	
BIO SPECIMEN TEST APPARATUS (J009)	14, 21	COMPLETE	10	0.012	16	
BIO/RADIOLOGICAL CONTAINER (J020)	8, 9	CONCEPTUAL	12	TBD	NONE	
GENERAL PURPOSE TEMP RECORDER	4, 19	COMPLETE	NIL	NIL	BATTERY	
UTENSIL/HAND CLEANING FIXTURE (J012)	1-7, 11, 12, 18, 21-24	PROTO COMPL	27	1.0	375	X
POCKET VOICE RECORDER (J013	20	COMPLETE	0.3	NIL	BATTERY	X
ELECTRODE IMPEDANCE METER (J032)	6, 23	COMPLETE	NIL	NIL	BATTERY	X
MINI SPECTROPHOTOMETER (J048)	4, 20	COMPLETE	0.46	0.0007	BATTERY	X

LIFE SCIENCES SCENARIO

SYSTEM/PROGRAM: Human Research Laboratory

The objective of this mission is to understand and mitigate effects of the space environment on humans to qualify a varied segment of the population for indefinite presence and operations in weightlessness, to increase the understanding of the space environment on biological processes, and to use the space environment to better understand life processes on Earth.

SYSTEM DESCRIPTION:

Purpose: To perform non-invasive research on human subjects to (1) further understand biological effects of space, (2) establish zero-gravity norms, (3) evaluate effectiveness of countermeasures, and (4) enhance our capability to use and explore space.

Lifetime: 10 years

Launch and Transfer Vehicle: Shuttle

Operational Locations: Low-earth orbit such as 28.5 deg except for radiation studies that will require either higher inclination or altitude.

Total Mass at Operational Locations: Approximately 5,000 kg

Average Operational Power: Approximately 4 kW

Desired Initial Operational Date: 1990

General Needs:

- Initial laboratory capable of supporting activities involving observation, monitoring, collection, and storing of specimens (e.g., blood, urine, and feces) for subsequent ground analysis.
- Laboratory to monitor microbiology of man and his environment.
- Increased capacity to include the establishment of zero-gravity physiological norms and to conduct biochemical analyses in space.
- Increased capacity to include instrumentation and facilities to fully evaluate physiological status in zero gravity.
- Physical Characteristics: 3m-long section of habitation module
- Resupply: 3 months for personnel change
3-6 months for consumables

Human Research Laboratory (Continued)

ARCHITECTURE/CONFIGURATION CONSIDERATIONS:

The Human Research Laboratory (HRL) will be an evolutionary outgrowth of a Health Maintenance Facility (HMF) and will be collocated with the HMF, utilizing some of the same items of equipment. The initial HMF will consist of an upgraded version of the Shuttle Orbiter Medical System that will be used for early missions where the Orbiter remains docked to the station. This facility provides no capability to conduct significant human research. The next step in the evolution of the HMF will be the addition of a first aid facility as part of the habitability module. This facility will grow to include a dedicated medical area with expanded treatment facility and will also form the basis of the HRL. The HRL will utilize the equipment with the HMF as well as having its own unique equipment for more sophisticated research.

CRITICAL TECHNOLOGY NEEDS:

Research

- o Definition of experiments and identification of required facilities.
- o Coordination of research activity with health maintenance.
- o Plans for implementation of research.

Hardware

- o Internal body imaging (tissues and bones)
- o Automated analysis, e.g., hematology, urinalysis
- o Microbiology

EXPERIMENTS AND FACILITIES:

Research Areas: (see Table 1)

Common Facilities: (see Table 2)

Human Research Laboratory (Continued)

CONTACTS:

A large number of persons were contacted to review and discuss the Human Life Sciences Research Facility requirements. Significant contributors included:

Dr. Larry Dietlein	Assistant Director, Life Sciences, NASA JSC
Dr. Sam Pool	Chief, Medical Sciences Division, NASA JSC
Hal Granger	Chairman, Space Station Sciences and Applications Working Group
Stuart Nachtwey	Chief, Biomedical Applications Branch, NASA JSC

TABLE 1 - HUMAN LIFE SCIENCES LABORATORY

	NO.	CARDIOVASCULAR	MUSCULOSKELETAL	HEMATOLOGY	IMMUNOLOGY	NEUROSENSORY	METABOLISM	BIOENGINEERING	SOLVES PROBLEM	REQUIRES 0 "g"	REQUIRES LONG EXPOSURE	REQUIRES MANNED ENVIR	POTENTIAL TERR BENE	CREW TIME REQUIREMENT (HOURS/SAMPLE/DAY) DURING FLIGHT	CREW TIME REQUIREMENT (HOURS/SAMPLE/DAY) POST-FLIGHT	EXPERIMENT UNIQUE HARDWARE	DATA REQUIRE-MENT
EXPERIMENTS IDENTIFIED BY NASA HEADQUARTERS	1. CENTRAL HEMODYNAMICS AND CARDIOVASCULAR REFLEX REGULATION	X									X		X	0.75		NONE REQUIRED	dc-50 Hz
	2. CRANIAL AND CEREBRAL CIRCULATION	X									X		X	0.50		NONE REQUIRED	TBD
	3. ORTHOSTATIC INTOLERANCE	X									X		X	4.00		COUNTER PRESSURE GAR.	TBD
	4. DIRECT MEASUREMENTS OF CALCIUM LOSS		X								X	X	X	0.75		NONE REQUIRED	TBD
	5. MINERAL AND NUTRIENT BALANCE		X				X	X			X		X	1.50		URINE AND FECAL STORAGE CONTAINERS	TBD
	6. BIOCHEMICAL AND HORMONAL MEASUREMENTS		X								X		X	1.50		URINE AND FECAL STORAGE CONTAINERS	TBD
	7. POSTFLIGHT BIOPSY(1)		X								X		X	1.50		NONE REQUIRED	TBD
	8. EFFECTIVENESS OF COUNTER MEASURES		X							X	X	X	X	0.25	1.50	NONE REQUIRED	TBD
	9. CONFIRMATION OF RED CELL MASS DECREASES AND RED CELL SHPAE				X						X	X	X	0.50	1.00	NONE REQUIRED	TBD
	10. KINETICS OF OTHER BLOOD CELLS				X						X	X	X	0.50	2.00	NONE REQUIRED	TBD
	11. POSTFLIGHT BLOOD CELL ANALYSIS IMPROVED METHOD				X	X					X		X	1.00	2.00	NONE REQUIRED	TBD
OTHER EXPERIMENTS	12. BEHAVIOR AND PERFORMANCE	X				X				X		X		1.00	2.00	NONE	TBD
	13. EXERCISE PHYSIOLOGY	X	X	X			X			X	X	X	X	1.00	2.00	NONE	TBD
	14. MUSCLE LOSS		X				X		X	X	X	X		–	2.00	NONE	TBD
	15. ANTHROMETRIC MEASURES		X							X	X	X		0.75	0.75	MEASUREMENT DEVICE	TBD
	16. IMMUNOLOGY			X	X		X				X		X	1.00	1.00	NONE	TBD
	17. VESTIBULAR SENSITIVITY					X			X	X	X	X		1.00	1.00	NONE	TBD
	18. SPATIAL ORIENTATION/HUMAN CONTROL					X			X	X		X		1.00	1.00	NONE	TBD
	19. RADIATION DOSIMETRY					X				X	X	X		1.00	–	NONE	TBD
	20. AUDITORY SENSITIVITY							X		X	X	X		0.50	0.50	NONE	20-20K Hz

HUMAN LIFE SCIENCES LABORATORY
COMMON FACILITIES - TABLE 2

FACILITY REQUIREMENTS	REQUIRED BY EXPERIMENT NUMBER	DEVELOPMENT STATUS	WEIGHT (kg)	VOLUME (cu m)	POWER (W)	ALSO REQUIRED FOR NON-HUMAN LIFE SCI LAB
ECHOCARDIOGRAPH (J046)	1, 12, 13	CONCEPTUAL	90	0.2	450	
BLOOD PRESSURE AND ECG (PHYSIOLOGICAL MONITORING SYSTEM PMS) (J008)	1, 2, 3, 12, 13	DESIGN	10	0.9	10	
PLETHYSMOGRAPH, LIMB (J023)	1, 13	FABRICATION	1.2	0.0004	BATTERY	
LOWER BODY NEGATIVE PRESSURE SUIT (J033)	1, 3, 13	PROTOTYPE COMPLETE	20	0.15	50	
RETINAL PHOTOGRAPH	2, 13, 14	NONE	TBD	TBD	TBD	
OCCULAR TONOMETER	2, 13	NONE	TBD	TBD	TBD	
INDIRECT PRESSURE RETINAL VESSELS	2	NONE	TBD	TBD	TBD	
DIRECT CALCIUM MONITOR (PHOTON AB, ACTIVATION, TOMOGRAPHY)	4, 13	NONE	TBD	TBD	TBD	
URINE SAMPLING AND STORAGE	5, 6, 16, 13	DESIGN	15	0.02	50	
FECAL SAMPLING AND STORAGE	5, 6, 16, 13	CONCEPTUAL	TBD	TBD	TBD	
REFRIGERATOR FREEZER (J044)	6, 8, 10, 11	DESIGN	70	0.30	200	
RACK MOUNTED CENTRIFUGE (J003)	6, 7, 10, 11, 16	COMPLETE	30	0.08	480	
IN-FLIGHT BLOOD COLLECTION SYSTEM (J005)	6, 8, 11, 13, 16	COMPLETE	8	0.05	NONE	X
MINI OSCILLOSCOPE (J001)	17, 18	COMPLETE	1.9	0.003	BATTERY	X
MICRO COMPUTER	15, 17, 18	COMPLETE	10.0	0.03	8	X
CASSETTE DATA RECORDER (J045)	15, 17, 18	COMPLETE	NIL	NIL	BATTERY	X
EVENT TIMER	13	CONCEPTUAL	0.2	NIL	BATTERY	X
COMPOUND MICROSCOPE	9	COMPLETE	15.0	0.01	60	X

FACILITY REQUIREMENTS	REQUIRED BY EXPERIMENT NUMBER	DEVELOPMENT STATUS	WEIGHT	VOLUME	POWER	ALSO REQUIRED FOR NON HUMAN LIFE SCI LAB
ROTATING CHAIR	17, 18	COMPLETE	100	1.2	1000	
LINEAR SLED	18	CONCEPTUAL	260	7.0	TBD	X
AUDIOMETER	15	CONCEPTUAL	TBD	TBD	TBD	
FAR FIELD POTENTIOMETER	15	CONCEPTUAL	TBD	TBD	TBD	X
EMG MONITOR AND SIGNAL CONDITONER (J011)	13, 14	COMPLETE	0.06	NIL	BATTERY	X
BICYCLE ERGOMETER (J024)	13	DESIGN	70	0.04	50	
GAS ANALYZER (J007)	12, 13	COMPLETE	41	0.1	150	X
UTINSIL/HAND CLEANING FIXTURE (J012)	1, 5, 6, 9-11	PROTOTYPE COMPLETE	27	1.0	375	X
POCKET VOICE RECORDER (J013)	3, 8, 12, 13, 17, 18, 20	COMPLETE	0.3	NIL	BATTERY	X
HEMATOCRIT CENTRIFUGE (J016)	9-11, 16	COMPLETE	0.83	0.009	BATTERY	
SMALL MASS MEASUREMENT (J061)	TBD	COMPLETE	17	0.04	15	X
BODY MASS MEASUREMENT DEVICE (J017)	15	COMPLETE	39	0.6	15	X
MULTI-CHANNEL STRIP CHART RECORDER (J018)	1-3, 12, 13, 17, 18, 20	CONCEPTUAL	30	0.09	500	X
URINE MONITORING (J027)	4-6, 8, 16, 19	FABRICATION	22	0.04	50	
VENOUS OCCLUSION CUFF	1, 12, 13	FABRICATION	2	0.001	BATTERY	
ELECTRODE IMPEDANCE METER (J32)	1, 3, 12, 13, 17, 18, 20	COMPLETE	NIL	NIL	BATTERY	X
LOW GRAVITY CENTRIFUGE (J043)	9-11, 16	CONCEPTUAL	12	0.04	345	
MINI SPECTROPHOTOMETER (J048)	12, 13	COMPLETE	0.46	0.0007	BATTERY	X
IMAGING/X-RAY	14, 15	CONCEPTUAL	TBD	TBD	TBD	X

ATMOSPHERIC OBSERVATION SCENARIO

SYSTEM/PROGRAM: Meteorological Payload

The payload consists of the Advanced Moisture and Temperature Sounder (AMTS), Advanced Microwave Sounding Unit (AMSU), and Microwave Pressure Sounder (MPS) with integration hardware. The payload is carried on an MPE support structure or equivalent.

The AMTS is a 28-channel infrared spectrometer that measures vertical profiles of atmospheric temperature and moisture.

The AMSU is a 20-channel microwave radiometer that measures the vertical profile of temperature and moisture. It will also measure precipitation distribution and intensity. Ground resolution is 50 km for channels 1 to 15 and 15 km for channels 16 to 20.

The MPS is an active microwave sensor using up to 6 channels to measure surface (sea level) pressure of the atmosphere.

SYSTEM DESCRIPTION:

Purpose: To provide continuous meteorological data for input to numerical weather prediction models

Lifetime: No limit

Launch Vehicle: Shuttle

Operational Location: Altitude, 400 km
Inclination, 57 deg

Operational Considerations: High inclination is required to provide latitude coverage; global coverage required twice daily.

Total Mass at Operational Locations: 1170 kg

Average Operational Power: 2 kW

General Needs:

- Physical Characteristics: 1.6 x 4.0 x 2.7 m
- Major Deployable Elements/ Internal Moving Parts: Instruments contain moving scan mirrors

Meteorological Payload (Continued)

- o Viewing Requirements: Payload requires radius orientation with instruments scanning crosstrack. AMTS requires orientation with respect to the velocity vector.
  - Pointing Accuracy: 6 arcmin
  - Stability: 6 arcsec
- o Emissions/Susceptibilities: MPS radiates microwave energy

  AMSU and MPS are sensitive to microwave RF interference at their operating frequencies. AMTS is sensitive to IR emission, absorption, or scattering and to condensation on optics.
- o STS Interfaces: TBD

<u>CONTACTS</u>:

OPERATIONS SCENARIO

SYSTEM/PROGRAM: On-Orbit Satellite Servicing in LEO

An important function for a space station in low-Earth orbit (LEO), can be to provide service to free-flying orbiting satellites also in LEO. Several modes of servicing are contemplated such as:

(a) Conducting maintenance, equipment replacement, propellant resupply by hands on, and robotic techniques at the satellite location.

(b) By capturing the satellite and performing the servicing at the space station.

It is envisioned that the space station should have the flexibility to accommodate either of the two modes for servicing.

To perform servicing functions, the space station must be augmented by orbit transfer vehicle elements to provide transport from the station to the orbiting satellite and return. Warehouse storage, propellant resupply and transfer, shop and checkout type facilities are required at the station to accommodate maintenance and assembly tasks.

SYSTEM DESCRIPTION:

Purpose: Conduct service operations on satellites in LEO

Lifetime: 10 years (lifetime of Space Station).

Launch and Transfer Vehicle : Via Shuttle and Orbital Transfer Vehicle (OTV).

Operational Locations: Station at 400 km altitude and 28.5 deg inclination

Satellites at various locations

Total Mass of Operational Locations:

- Satellites
- OTV
- Service facilities at Space Station

Desired Initial Operational Date: 1994

GENERAL NEEDS:

- o Fuel/oxidizer/pressurant storage and transfer
- o Warehouse storage
- o Servicing, assembly, and checkout area
- o Checkout systems
    - Mechanical - tankage/line leak checks - valve functional checks
    - Electronics - subsystem input-output
- o Checkout data system - electronic automatic sequencing and signal monitoring/control and status
- o Operational crew - 10 person crew including technicians
- o Orbit transfer vehicle - (manned and unmanned)
- o Robotic manipulators for performing servicing at satellites

CONTACTS:

ON-ORBIT SATELLITE SERVICING IN LEO SCENARIO (INTEGRATED TACTICAL SURVEILLANCE SYSTEM)

SYSTEM/PROGRAM: Integrated Tactical Surveillance System (ITSS) Servicing in Low-Earth Orbit

A major goal to achieve economical free-flyer satellite operation is to effectively expand the on-orbit life of the satellite by conducting on-orbit servicing.

The objective of this scenario is to provide servicing in LEO for the ITSS including equipment replacement, subsystem modification, repairs, replenishment of expendables for the ITSS free-flying satellite at periodic intervals.

ITSS is a program to define the Navy surveillance/command, communication, and control (C^3) improvements in support of the anti-air warfare and surface/subsurface warfare. Surveillance and C^3 problems are increasingly magnified as air and sea launch weapon ranges increase. Both existing senso command and control (C^2) improvements and new sensor C^2 systems are being defined. In addition, the Air Force has augmented the ITSS effort.

ITSS is expected to fill deficiencies in both C^3 and surveillance. The C_3 improvements address the use of existing sensors in conjunction with new sensor systems. Processing and timeliness in a warfare environemnt are key issues. For the new sensors, the ability to provide attack warning and weapon placement data re key issues. As such, the ITSS architecture is expected to drive both sensor and C^3 improvements in the late 1980s to the 1990s.

SYSTEM DESCRIPTON:

ITSS Satellite

Purpose: Protect the U.S. Navy fleet from attack and inform Air Force of impending aerial attacks

Lifetime: Classified (greater than 3 years)

Launch and Transfer Vehicle: Initial launch from Shuttle

Operational Location: 1000 and 2600 km at both 65 deg and 57 deg

Total Mass at Operational Location: 10,000 to 11,000 kg

Average Operational Power: 13 kW average

Desired Initial Operational Date: Early 1990

Integrated Tactical Surveillance System Servicing in Low-Earth Orbit (Continued)

General Servicing Needs:

- Servicing frequency: TBD
- Servicing Needs: Fuel/OX/pressurant resupply
Equipment changeout - various items in 8 subsystems
- Support for servicing and ITSS C/O after servicing scenario
- Servicing uses STS based teleoperator or 'mini OTA/MOTV'
- Data link to station for servicing C/O (10M/bits/sec)

CONTACTS:

LARGE SATELLITE ASSEMBLY IN LEO
SPACE-BASED RADAR (SBR)

SYSTEM/PROGRAM: Space-Based Radar

The SBR will consist of a group of interrelated sensors and associated support equipment for use in earth-looking observation modes. The total sensor and equipment complement will be mounted on a large space structure assembled and tested at low-Earth orbit (LEO) for subsequent redeployment to high-Earth orbit (HEO). Servicing (e.g., consumables) could be accomplished remotely with a LEO-based servicer.

SYSTEM DESCRIPTION:

Purpose: To view in a surveillance mode specific Earth geographical locations for intelligence gathering, examination, and verification

Lifetime: 5 to 10 years (including servicing)

Launch and Transfer Vehicle: Shuttle to station, propulsion module (LEO to GEO transfer) and possible teleoperator

Operational Location: Primary GEO (Payloads)

Total Mass at Operational Location: Approximately 15,000 kg

Desired Initial Operational Date: 1988 (Shuttle-based experiment: 60m reflector)

1993 (Station constructed with SBR launch to GEO)

General Construction Support Needs:

- Construction in LEO: Both IVA and EVA crew support plus construction equipment
- SBR Platform Stability 1/10 of antenna beamwidth
- Data rate of 50m/bits/sec
- Propulsion modules for transport from LEO to HEO
- Potential use of teleoperator
- Physical Characteristics: 225m antenna (reflector size)
- On-orbit servicing

Space-Based Radar (Continued)

- C/O of SBR pre- and postlaunch transfer to GEO
- Comm/data links to ground and to TDRSS (military dedicated?)

CONTACTS:

ASTRONOMY PLATFORMS AND MSS DERIVATIVES

SYSTEM/PROGRAM: Space Platform Servicing - Free Flyer (Astronomy Platforms and MMS Derivatives)

As the Space Transportation System is augmented and evolving in the 1990-2000 era, free-flyer platform elements will be added to operate in an autonomous mode. These free-flyers will accommodate experiments and payloads for long-duration-type observation where low-g and low contamination criteria can be maintained. Many of these free-flyers are presumed to be man-tended at periodic intervals.

An important operational function of a Space Station will be to provide the capability to execute service missions to these platform to resupply expendables, conduct maintenance, repair/replace equipments, modify experiments, etc. It is anticipated that these missions will be conducted on a scheduled basis and also that the capabilty should exist to conduct an occasional emergency-demand-type visit.

SYSTEM DESCRIPTION:

Purpose: To perform service operations in support of free-flying platforms.

Lifetime: Life of Space Station

Launch and Transfer Vehicle:

- o Shuttle - S/C to orbit
- o Shuttle - spares/fluids for servicing (pre-STA era)
- o Shuttle - spares/fluids to station
- o P/L handing unit (S/C transfer to/from STA)

Operational Location: Platform located in LEO at 28.5 deg and altitude of 370 to 550 km

Total Mass at Operational Location: Approximately 6,800 to 11,000 kg

Average Operational Power: TBD

Desired Initial Operating Date: Varies from 1984 to beyond 1988

General Platform Support Needs: TBD

Space Platform Servicing - Free Flyer (Astronomy Platforms and MMS Derivatives) (Continued)

- On-Orbit servicing
- Capture and holding/positioning for servicing
- Spares and fluids resupply
- Potential use of P/L handling unit
- Checkout data rate of TBD
- Physical Characteristics: 2.5 to 4.4m diam., 3 to 14m long, and arrays up to 6m each
- Comm/Data Links: S/C to TDRSS (up and down link), possible station link.

CONTACTS:

LMSC-D889718

SPACE STATION PROGRAMS

ATTACHMENT 2
SUPPORTING DATA AND ANALYSIS REPORTS
VOLUME I

COMMERCIAL REPORT

Lockheed

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STUDY OF COMMERCIAL REQUIREMENTS

FOR

FUTURE SPACE SYSTEMS

BY

P.G. GRODZKA

CONTENTS

INTRODUCTION

With the prospect of routine operation of the Shuttle near at hand, NASA has begun a planning activity to define future space systems. Before even contemplating any specific configurations, however, NASA has set itself the task of determining user requirements to ensure that the system designs will be driven by user requirements and not vice versa. A number of major aerospace contractors were contracted to help NASA achieve this objective. Lockheed was one of the selected contractors.

The potential user community is divided into several sectors: national security, foreign, science applications, and commercial. This report deals with Lockheed's efforts in determining commercial user requirements.

The commercial sector has divided itself thus far into satellite communications, remote sensing, space manufacture of unique products, and support services for the preceding three areas. Although business interests are already active in varying degrees in all of the cited areas, the vast majority of the business community has not yet even thought of what they might do in space. Reasoning that the needs and requirements of the presently active business firms probably are already, or shortly will be, well canvassed by NASA and other competitive contractors in the present contracted effort, Lockheed chooses to concentrate on trying to elicit responses from the thus far silent majority.

Lockheed decided that any meaningful participation of the business community in defining future space systems requirements would first require establishing an ongoing dialogue between the potential users and systems designers. A two-pronged strategy was thus devised for establishing such dialogues with production and financial businesses that are relatively uniformed and widely dispersed. The management consultant firm of A.D. Little was subcontracted to help Lockheed educate and stimulate interest in space commercialization. A.D. Little organized and presented two seminars to carefully selected industrial leaders. Concurrent with this activity, a number of selected firms were visited, some of which were represented at the A.D. Little seminars. Contact was also established with two professional trade organizations, and a personal presentation to the board of directors of one was given.

In addition, some other avenues to involving the commercial sector by, so to speak, the side door were explored. These included trying to interest the Air Force in undertaking an exploration of the possibilities of space for materials processing and treatment of human disabilities and determining if the National Bureau of Standards had requirements for performing physical properties determinations in space. The rationale for this approach is that the Air Force has specific needs in the mentioned areas and itself performs or contracts a great deal of research and development to answer those needs. Should the Air Force find that space offers a real advantage for either space produced materials or space treatment facilities, it could provide a market for the materials or facilities. Commercialization of the technology would thus be rapid indeed. In

the case of the Bureau of Standards, determination of physical properties in space would call for new apparatuses that would challenge the ingenuity of instrument manufacturers. Advances in the art of instrumentation have always led to breakthroughs in technology that have benefited not only the instrument makers but have also spawned new industries.

A full report of the A.D. Little seminar activity is presented in another volume. The remainder of this report concern itself with the personal visits.

SELECTION OF COMPANIES AND VISIT ARRANGEMENTS

Because the period of performance of the present contract was quite short, essentially September 1982 to March 1983, a number of visits had to be arranged before personal contacts could be made at the A.D. Little seminars. Past experience in the space processing field served in helping to identify a few likely candidates. Identification of other likely firms in an area was accomplished by intensive library research.

Once a list of likely candidate firms had been assembled, setting up appointments was performed by means of telephone and letter contact. The telephone route proved more efficient in setting up a string of appointments in a short period of time. Letters are apparently too easy to pass on to other people. Letters, however, might be more effective if sufficient time is available for letting the letter find the right person.

VISIT FORMAT

A visit usually took the following format:

- Preliminary remarks about NASA needing user requirements.
- Giving individuals a chance to respond. The usual response was that they hadn't given the matter much consideration.
- The Lockheed representative would then present an overview of the possibilities of space.
- Discussions after the presentation of particular interests.
- Lockheed would introduce and leave with the firm the Lockheed-devised first-cut senarios to aid in obtaining feedback from the companies. (Appendix A shows copies of these senarios).

In a number of cases, the companies had assembled rather sizeable audiences, so the presentation was more formal. The presentation was aided by a number of visuals assembled from files or solicited from contacts.

COMMERCIAL COMPANIES VISITED

Figure 1 shows the companies visited. Names of the persons contacted are given in Appendix B. The column titled Encounter in Figure 1 shows entries such as ADL/1 and T/1. The letters ADL and T indicated that the initial contact was made either at an A.D. Little seminar or by telephone. The number following the letter indicates the number of personal visits paid to the firm. The column titled Rating shows the perception of the degree of interest in pursuing space research and development. The following general interpretation of the ratings apply:

1... High interest. Indication of initiation of a formal evaluation.

2... High interest, but need more indication of thinking of others in organization.

3... Moderate interest. Want to be kept informed.

4... Interest. See no immediate opportunities but open to new developments.

5... Minimal interest or even rejection of concept.

FIGURE 1
COMPANIES VISITED

COMPANY	ENCOUNTER	RATING
Dayton Malleable, Inc. Dayton, Ohio	T/1	3
The Duriron Company, Inc. Dayton, Ohio	T/1	2
Systems Research Laboratories, Inc. Dayton, Ohio	T/1	4
National Cash Register (NCR) Dayton, Ohio	T/1	1
Mead Dayton, Ohio	T/1	2
Borden, Inc. Cincinnati, Ohio	T/1	3
Cincinnati, Inc. Cincinnati, Ohio	T/1	3
KDI Precision Products, Inc. Cincinnati, Ohio	T/1	3
Borg-Warner Chicago, Illinois	T/1	2
G.D. Searle & Co. Shokie, Illinois	T/1	3
Gould, Inc. Rolling Meadows, Illinois	T/1	5
Celanese Chemical Company Dallas, Texas	T/1	4
Vought Corporation (an LTV company) Dallas, Texas	T/1	3
Commercial Metals Company Dallas, Texas	T/1	3
Hughes Tool Company Houston, Texas	T/2	1

FIGURE 1
COMPANIES VISITED (cont)

COMPANY	ENCOUNTER	RATING
Pennzoil Company Houston, Texas	T/1	3
Consolidated Aluminum St. Louis, Missouri	T/1	1
Monsanto St. Louis, Missouri	T/1	2
Dart-Kraft, Inc. Glenview, Illinois	T/1	4
UOP Des Plaines, Illinois	T/1	2
Travenol Laboratories, Inc. Morton Grove, Illinois	ADL/1	2
Exxon Production Company Houston, Texas	T/1	2
Bacti-Consult Associates Houston, Texas	ADL/1	3
Corning Glass Works Corning, New York	ADL/1	1
Alcoa Pittsburgh, Pennsylvania Alcoa Center, Pennsylvania	ADL/2	1
Hercules, Inc. Washington, D.C.	ADL/1	2
AMP, Inc. Winston-Salem, North Carolina	ADL/1	2
Becton Dickenson Paramers, New Jersey	ADL/1	3
Allied Corporation Morristown, New Jersey	ADL/1	2
Mobil New York, New York	ADL/2	1
Raychem Corporation Menlo Park, California	ADL/1	2

OBSERVATION ON COMMERCIAL SECTOR'S READINESS FOR SPACE VENTURES

Extent of Current Commercial Activity: Assessing the full scope of present commercial activity in space was beyond the scope of the present study. We were struck, however, by the amount of activity that is occurring, apparently entirely independent of NASA. Mr. Art Dula of Houston, Texas, one of the foremost space lawyer in the country, said he had a number of clients that were pursuing a number of space activities independent of NASA funding. Dr. Lorraine Gall, also in Houston, Texas a consultant in the area of microbiology, said that she too was performing services for clients pursuing independent commercial space ventures. Both would not divulge further information on the nature of these activities.

Possible Space Ventures of Interest to Industry: As mentioned previously the majority of the firms contacted were very receptive to hearing about the possibilities of space. Only one firm, however, had independently formulated any specific interest. Mr. G. Keith Turnbull, Alcoa's Director of Technology Planning, was interested in the possibilities of energy from space for the purpose of running aluminum refining operations. As Mr. Turnbull explained, an aluminum refining operation is first located where power is plentiful. The operation then attracts considerable people and business activity into the area. The increased population in turn generates its own demand for power, which competes with that of the aluminum operation. If power from space could be economically obtained it could be directed to populated areas where aluminum production facilities already exist or could economically be built, even in deserts. The cost of transporting the raw ore, bauxite, is negligible, compared to the refining energy cost. Energy from space might thus be a way to revitalize some severely economically depressed regions of the country.

The rest of the firms visited did not indicate prior formulation of any specific interest. Most of the firms had not yet thought of space in any serious way. Of the possibilities suggested, the following kindled the most interest and enthusiasm:

> Space processing-metallurgical, electronic, glass, catalyst, and biological or pharmaceutical products.
>
> Recycling materials in space - i.e., cutting up, in space, the large Shuttle external tank and processing the material for other uses in space.
>
> Construction of large space structures - using metal or plastic products.

The areas of food production, and health care, were rather coolly received, although not rejected. These areas apparently appear to be too far in the future for serious consideration now.

Awareness of State-of Space Technology and Arrangements for Participation: There exists in the commercial sector a general lack of knowledge of the possibilities of space, of prior work in the area, and of how access to space may be gained.

Knowledge of NASA's arrangements for dealing with the commercial sector are also generally unknown. Most of the firms contacted displayed great concern about the extent and nature of foreign activities in space and a number of requests for further information on what the Japanese and Germans are doing were received. Desperately needed is some general descriptive material on the areas mentioned that is written especially for the business community.

All of the firms contacted, even those who have informed themselves on NASA research and development in commercial areas, need help in identifying ways in which space might be used to their particular commercial advantage. part of this need is caused by poor communication of what has already been accomplished in space, but a large part is due to the very small existing data base of actual space phenomena. The individuals contacted readily grasped and displayed great interest in the demonstration science experiments. These demonstration experiments showed phenomena that they could relate to and sparked their imagination. A larger data base of these kinds of experiments would be very beneficial to educate the business community.

Evaluation Activities Precipitated by Visits: As can be seen in Figure 1 a fairly high percentage of the firms showed high interest in the possibilities of using space for commercial purpose. Some of the specifics of the evaluation activities initiated by the firms as the result of Lockheed's contacts are:

- NCR Corporation

  The people a NCR indicated that they would pursue space processing research and development through the Microelectronics and Computer Technology Corporation (MCC). This corporation is a cooperative venture of 15 U.S. companies. NCR will bring up the matter to MCC sometime in the near future.

- Hughes Tool Company

  A study project was initiated to determine if an advantage could be realized from space for manufacturing drill bits. It was decided, however, that the project required a research effort beyond what the company was willing to undertake. Future contact to determine the factors that went into this decision is planned.

- Consolidated Aluminum

  Mr. Kurt Hulliger said he would introduce the matter of space research and development activity to the corporate board in Switzerland sometime in February.

- Corning Glass Works

  Dr. Gail Smith was designated to track and define efforts in the space research and development area.

- Alcoa

  Mr. Henry Patis was designated to head a project to determine what Alcoa's interest in space might be.

- Mobil

  Mr. J.J. Wise indicated that Mobil would probably try some Get Away Special Experiments. On 6 April 1983 they visited with Goddard which meeting was organized by Lockheed at Mobil request.

Feedback-to-Date: Only a couple of responses were received to the request for comments on the senarios. These responses were not very detailed, more in the nature of, well, they look all right. It is too soon to expect more at this time.

Follow-Up Activities to Date: The major follow-up activities accomplished since the visits were made have consisted of gathering and mailing specific descriptive and technical information requested in the visits.

Some Larger Issues That Emerged: Various concerns were expressed by the individuals at industrial firms. One of the most significant was the concern as to the advisability of pursuing even exploratory research and development if commercialization is not certain. There was a fear that the research and development might be picked up by foreign firms, who would commerialize it perhaps to our detriment, i.e., the way Japan used continuous casting to the detriment of the U.S. steel industry. Apparently something of this sort is happening in the solar photovoltaic area also (see article presented in Appendix D). If this indeed is a problem of the magnitude suggested, then both industry and Government must do some very serious thinking about the objectives of research and development and how it is funded. At the very least, the oft-stated and industry-endorsed position that Government thould fund high risk research and development needs to be reexamined.

Apropos of foreign use of U.S. research and development is the question of the effect of heavy U.S. investment in foreign high-technology start-up companies in Europe (see Appendix E). It appears that some adjustments to U.S. tax rates must be made or the U.S. may lose not only substantial venture capital, but also our technology lead.

Another issue emerged, not through conversations with industrial firms, but through a letter exchange in Astronautics and Aeronautics (Appendix F). The main point brought out by the letters is that the larger user community may be overlooked when we try to identify industry needs for space systems. As the letters bring out, projections for needs such as an educational satellite require the participation of economists, educators, and other soft-science specilists. A failure to adequately assess the nature and future markets has caused the satellite communications industry to overestimate their requirements*.

Finally, consideration of the needs and requirements of foreign nations for future space systems cannot be considered independently of U.S. commercial needs and requirements. In particular, the third-world nations cannot be viewed only

as a source of markets for U.S. commercial firms. A mechanism will have to be sought to involve the third-world nations in an active way in any large future space system. The Sabre Foundation's idea of free trade zones for space venture, (i.e., areas where enterprises are exempted from tariffs and taxes) promises a start in this direction. A contact has been established with the Sabre Foundation and future interaction should provide more concrete possibilities.

RESULTS OF COMPLEMENTARY ACTIVITIES

Trade Association: Two trade associations were contacted in the course of the study. These were the Metal Powder Industries Federation (MPIF) and the Electronics Representatives Association (ERA). A presentation was given to the MPIF board at their annual meeting.

Both organizations are very enthusiastic about learning more about space possibilities and about undertaking activities that would inform and serve their member organizations better to take full advantage of possible opportunities. One of the activities suggested was association sponsorship of some space experiments. Both associations were very enthusiastic about Lockheed having an information booth and giving papers at their annual conferences and exhibition (Appendix G). The MPIF will be held their conferences and exhibition on MA 1-5, 1983. The ERA technial conference and exhibition will be held April 19-21. Some 75,000 people are expected to attend. There will be some 800 exhibitors.

Possible Air Force Activity: A presentation to a group from the Air Force Materials Laboratory (Appendix B, p. 1) was received with interest, but there was little indication that any concrete evaluation activity would result. Possibly the right people were not reached. This will need to be explored further, but prior experience with trying to identify a group within the Air Force that would be interested in space processing left the impression that the Air Force considers any space materials research and development strictly a NASA province.

Dr. L.E. Kazarian of the Air Force Aerospace Medical Research Laboratory was contacted by telephone. Dr. Kazarian is involved in research activities having to do with the effects of space on various human processes. Dr. Kazarian had not considered using space for treatment facilities, but he offered the possibilities that space might be useful for treating scoliosis, burns, some circulatory problems, and head injuries. He offered the fascinating bit of information that space is apparently a cure for chronic low-back pain. This bit of information should be of great interest to the commercial sector. A health spa in space?

Dr. Kazarian thought that the most probable use of a space station will be as an intermediate, rehabitation place to gradually adjust deep-space astronauts to gravity before returning to earth.

National Bureau of Standards (NBS) and CINDAS: CINDAS (Center for Information and Numerical Analysis and Synthesis) is a DoD information analysis center. Its funding is 60 percent DoD, 30 percent NBS, and 10 percent Purdue University. There are 20 of these information centers throughout the country. The main

function of these centers is to collect, review, analyze, appraise, summarize, and store available information on highly specialized technical subjects. CINDAS specializes in thermophysics and electronic data. In addition to paper studies they also perform some experimental determinations of physical properties.

Neither NBS and CINDAS has any long-ranged plan to use space for physical properties determination, although NBS does conduct a number of studies, under NASA sponsorship, in the area of space processing. At both organizations, however, conversations with the technical personnel indicated that they had highly imaginative ideas for the use of space for physical properties determinations.

CONCLUSIONS

The commercial sector, as evidenced by the sample of the 32 firms personally visited, are for the most part abysmally uninformed on the possibilities of space, the state-of-the-art space technology, how access might be gained through NASA channels, and the extent of foreign space activities. All were eager to rectify the situation, however. Those firms that had some knowledge of space technology and possibilities couldn't see any concrete possibilities for themselves. A large part of this lack of opportunity recognition is surmised to be caused by the lack of an adequate data base of space physical phenomena and space economics.

The approach taken in the present study of establishing in-depth personal contact to initiate a dialogue was shown to be successful as evidenced by the unanimous agreement of the contacted firms to continue the dialogue and by the evaluation activities precipitated by the visits.

An interesting finding of the present study was that many, if not most, Government agencies, some which have a stake in space, have also failed to recognize how space can help them fulfill their earth-and-space-based needs. It is felt that the commercial sector's entry into commercial space activities would be greatly facilitated if the Government agencies themselves would use space for some of their own material, medical, and other needs.

Lastly, a number of socio-economic issues, which surfaced during the course of the study, need to be considered more fully lest the U.S. find that the way companies and the Government have been conducting research and development activities is having detrimental economic and political effects.

RECOMMENDATIONS

The major recommendation and most easily implemented, is that more adequate and comprehensive information, written especially for the business community, be prepared and made available. Some of NASA's literature is suitable for the business community, but most is not. A series of brochures or books on physical phenomena in space, possible space commercial ventures, extent and kind of foreign activity in space, and access to space would be very convenient for introducing the subject to previously uninformed people.

Continuation of the in-depth dialogue process is recommended and should be expanded somewhat in order that a realistic assessment of its value can be made. Obviously one or two visits will not get a commercial company to pursue a drastically different economic objective. How long will the process take? How can the process be shortened? These are questions that require more data before an adequate answer can be given.

It is also recommended that the data base of physical phenomena in space that is relevant to the commercial sector be expanded. To this end, an input from industry as to what they would like to see should be solicited. The in-depth dialogue technique, the main tool of the present study, should be ideal for eliciting this input.

Trade associations should be involved in helping to inform and involve industry in space activities. Their conventions and trade shows should be excellent vehicles for disseminating information and for identifying companies with low activation energy barriers for entry into space commercialization exploration activities. Along these lines, talks to Chamber of Commerce gatherings in places like Houston, Dallas, New York, etc., should also be tried.

It is also recommended that further efforts be expanded to interest various Government agencies that may have material, medical, and other like needs that could perhaps be fulfilled better by space activities.

The socio-economic issues discussed need clarification and study before specific recommendations can be made. Studies of this nature, therefore, are recommended.

APPENDIX A

SAMPLE SPACE SYSTEM SCENARIOS USED TO STIMULATE COMMERCIAL RESPONSE

a. Materials Processing Scenario
b. Space Manufacturing Scenario

(SEE ATTACHMENT 2, VOLUME I, SCENARIOS)

APPENDIX B

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Appendix C

DESCRIPTION OF NEW ORGANIZATION FOR COOPERATIVE CORPORATE R&D

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R&D COOPERATIVE

Electronics, computer R&D are aim of joint project

RECOGNIZING what many authorities fear is a sliding U.S. lead in electronics and computer technologies, 15 U.S. companies have joined to begin a coordinated R&D project. The venture has spawned the Microelectronics & Computer Technology Corp. (MCC).

The joint effort is a response to stiff competition in the worldwide electronics market. It also is an effort to combat an ambitious Japanese "fifth generation" computer project that could propel the Japanese to the forefront of computer technology by the year 1990.

Robert Price, president of Control Data Corp. and chairman of the MCC steering committee, said, "We now have the formal structure into which participants can invest financial and intellectual resources needed to address the threat to U.S. preeminence and predominance in the semiconductor and computer industries."

In outlining the functions of MCC, which has been formally incorporated, Price said that there will be four areas of initial interest. These four are:

□ Microelectronic packaging project that will concentrate on accommodating future VLSI chips having a million or more circuit elements. Researchers also will study automated assembly techniques for the packaging.

□ Advanced computer architecture project that will be an 8- to 10-yr effort focusing on knowledge-based architectures, artificial intelligence, and their applications.

□ Computer-aided design and manufacture that will include developing advanced electronic CAD/CAM design tools and incorporating them into an overall system. The system will have the capabilities to design, lay out, and simulate microelectronic chips with up to 10 million circuit elements. This program will use advances from the computer architecture effort.

□ Software productivity that will develop techniques, procedures, and tools to provide an order-of-magnitude improvement in the effectiveness of software systems and application of software development processes.

Price said that the initial annual budget of MCC will be in the $50- to $100-million range and that each company involved will share in the expense.

The companies presently making up MCC are Advanced Micro Devices Inc., Burroughs Corp., Control Data Corp., Digital Equipment Corp., Harris Corp., Honeywell Inc., Mostek Corp., Motorola Inc., National Cash Register Co., National Semiconductor Corp., RCA Corp., Signetics, Sperry Univac, Westinghouse Electric Corp., and Xerox Corp. □

Appendix D

AN EXAMPLE OF FOREIGN COMMERCIALIZATION OF U.S. R&D

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From INDUSTRIAL RESEARCH & DEVELOPMENT — September 1982, p. 76

SOLAR

U.S. research in PV cells is paying off in Japan

EVALUATION OF advances in photovoltaic energy conversion technology, reported at the recent Materials Overview meeting of the Society for the Advancement of Material & Process Engineering (SAMPE) in San Diego, CA, shows that there's both good news and bad.

The good news, as Dr. Satyen Deb, chief of Solid State Photovoltaic Research Branch, Solar Energy Research Institute, Boulder, CO, emphasized to SAMPE, is that there has been important progress in a wide range of thin-filament photovoltaic (PV) materials. The bad news—inferred from his discussion and from the views of other PV experts—is that there's a good chance that the major rewards may go elsewhere, despite pioneering U.S. efforts in the field.

A good example is amorphous silicon R&D. This is one of a number of thin-film systems which may lead to significant reductions in device costs. Deb noted that with conventional silicon-based systems, the price per peak watt (W_p) should come down to about $0.70 by 1986. While much lower than at present, this is still too high for PV systems to compete with other approaches. For that, he said, a range of $0.15 to $0.40/$W_p$ is necessary, a level he sees attainable with technologies based on thin films, such as amorphous silicon or several nonsilicon semiconductor materials.

For amorphous silicon, he told SAMPE, "an almost explosive growth in R&D has occurred," much of it outside the U.S. The first devices of this kind, he pointed out, were fabricated in 1974 at RCA Laboratories, Princeton, NJ, using thin films of α-Si:H pin and Schottky barrier structures. However, he said, recently "some of the major advances in materials and devices have come from Japan."

(Dr. David Carlson, who heads up the RCA amorphous silicon program, recently told *IR&D* that dwindling U.S. government support for PV R&D has played a part in this situation. "After we published some of our findings, the Japanese jumped in. You could argue, perhaps, that we should have made the data classified. In that case, however, practical applications might have been pushed much farther back.")

Deb reported that the Japanese have achieved the highest efficiency thus far in amorphous silicon. "The highest conversion efficiency of 8% reported to date was achieved on an α-SiC:H/α-Si:H cell structure fabricated by Osaka Univ."

Appendix E

EXAMPLES OF HEAVY INVESTMENT BY U.S. FIRMS IN FOREIGN R&D

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From THE WALL STREET JOURNAL, Wednesday, February 23, 1983, p. 34

Sweden's Stock Market Rally Powered Partly by Rise in U.S. Investment in 1982

By Stephen D. Moore
Special to The Wall Street Journal

U.S. Investing Spurts

The most enduring effect of the Stockholm bull market is likely to be the addition of a handful of Swedish glamor shares to portfolios of American institutional investors. Foreign buyers were a driving force in sustaining the rally last year, accounting for 13% of all buying and selling of the Stockholm exchange. U.S. investors were responsible for two-thirds of the [illegible] million in net share exports from Sweden, an increase from the $25.4 million in net share exports to all countries in 1981.

Initial investor interest, primarily from United Kingdom brokers beginning in the late 1970s, was generated by a few pharmaceutical companies such as AB Astra and AB Fortia, which have unique properties and products. In addition, many major Swedish companies were cheap, with shares costing up to 50% less than their American counterpart companies, Swedish brokers say.

According to Ake Rydberg, an investment broker at Skandinaviska-Enskilda Bank, "Swedish companies have made extremely good progress in niches international investors love to see—telecommunications, pharmaceutical and agricultural biotechnology, and robotics. Another strong factor is the high proportion of successful products, with profit dilution from unsuccessful items far less than for larger, international competitors."

From BUSINESS WEEK, August 16, 1982, pp. 31-32.

Monsanto is mining Europe's high-tech lode

Monsanto Co. has pooled resources with several British universities, including Oxford and Cambridge, to set up a $17.5 million venture capital fund in London that will invest in high-technology start-up companies in Europe. The action is the first major entry into Europe's fledgling and undercapitalized venture capital community by a U.S. industrial company. If the move works for Monsanto, other U.S. corporations are expected to follow suit.

Monsanto, of St. Louis, says its chief aim is to establish a window on new technologies that it may want to incorporate into its future business strategies. Moreover, Monsanto believes it will have first pick—and big capital gains later—since venture capital investment in Britain is growing as a result of recent favorable changes in British tax laws and the Thatcher government's emphasis on stimulating new business development.

Open-arms attitude. "It's a relatively cheap and noncommittal way to follow technology through its formative stages to see if it fits into our long-range plans," says L. Edward Klein, director of Monsanto's New Ventures Group, "and it could lead us into new areas for consideration." Because of Britain's open-arms attitude, the fund will immediately invest in British companies and then plans to scout companies in Holland, Sweden, and Scandinavia, depending on the investment climates in those countries. Special interest will be focused on such hot new areas as microelectronics, robotics, chemical and agricultural technology, and genetic engineering. An advisory board that includes British and Monsanto scientists will oversee the investment decisions.

About 15% of the fund, called Advent Eurofund Ltd., is being capitalized by universities seeking a high yield from the investment. Some of the schools want to form relationships with entrepreneurs that will aid their own research projects or provide opportunities to commercialize developed technology.

The move is the first major U.S. entry into Europe's venture capital community

Also participating are St. Andrews University and Imperial College (London) in Britain and Boston University in the U.S. Advent Eurofund's managers also have a share, while some British financial institutions are expected to take a part of the fund, which will close out by the end of August, Monsanto says. Monsanto itself is investing its 50% share through its European operations, which are headquartered in Brussels.

Full control. Advent Eurofund, which will manage the 10-year limited partnership fund and pick its investments, is a subsidiary of Boston-based venture capitalists TA Associates, one of the few U.S. venture firms now investing in European-funded pools. This new partnership will be headed by British entrepreneur David J. Cooksey and is the first to receive substantial sums from U.S. sources.

Typically, Advent Eurofund will buy minority equity positions in companies and then split the ownership stakes among Monsanto and the other participants according to the percentages of their original contributions. Advent Eurofund, as managing general partner, will also receive a small part of the ownership stake and a portion—usually 20%—of the capital gains for its investment advice and oversight responsibilities. The entrepreneur will have full control over any products that are developed, but Monsanto says it hopes to negotiate licensing agreements with some of the companies.

Monsanto is an old hand at the venture capital business. In 1972 it was one of the forerunners in corporate venture capital investments when it started InnoVen Capital Corp. in a joint venture with Emerson Electric. InnoVen is run by an independent partnership that picks and manages the investments. Monsanto has also made research agreements with Washington University in St. Louis and Harvard University medical school to develop pharmaceuticals (BW—June 21). ■

Appendix F

LETTER EXCHANGE DISCUSSION OF ROLE OF LARGER USER COMMUNITY IN SPACE PROJECTS

From ASTRONAUTICS & AERONAUTICS, October 1979, p. 8

FOR MULTIPURPOSE INSTEAD OF DEDICATED BIG COMSATS

I have great respect for Ivan Bekey and his accomplishments, but I deplore his article, "Big Comsats for Big Jobs," in the February 1979 issue of *A/A*. I am disturbed by the statement that the large-scale satellite services *might* have some *transient* adverse social and institutional impacts. It doesn't take much imagination to realize that *unquestionably* there would be *permanent* and *major* social and economic impacts. It is extremely unfortunate that economists, educators, and other soft-science specialists did not collaborate on the article. Bekey should look into some of the economic studies of developing countries done for AID.

For example, examining the educational-TV portion of the article, I find a strong implication that video tapes can teach. Professional educators know that TV is no more than a tool among a myriad of tools that are needed in the classroom. Thus, the TV programs are only one line in the budget of the school systems and far from the largest line. Costs for *both* the space initiative and ground alternative in Bekey's article are utterly out-of-line. This is because he projects usage of ETV to the exclusion of all other media. A more realistic usage projection would not preclude the adoption of Bekey's system. It would merely mean that a dedicated satellite would not be needed and channels on a multipurpose satellite could be employed.

Another error is in estimating the cost of producing an hour of educational TV. The figure of ten thousand dollars is far too low. Minimum cost is around twenty thousand and some programs can run as high as a hundred thousand. Most of the cost is in developing the program, because it involves the use of high-priced educational specialists and a great deal of testing and redesign to validate the programs. Bekey says nothing about who is to pay the cost of the software. Currently, licensing with royalty payments is employed. How would this be handled in this system?

My recommendation to Bekey would be to revise downward his grandiose scheme of dedicated satellites. The giant satellite of the future is a natural for a multi-purpose vehicle. It should not be difficult to obtain *realistic* projections of requirements for communications, electronic mail, and ETV. Bekey should then have no difficulty designing a multi-purpose system that should be *feasible in a much nearer future.*

Irving Dlugatch
Dean of Students
California Western University

REPLY TO DLUGATCH

Professor Dlugatch missed the main point I tried to make in my article: that only through a dedicated large-antenna, high-power satellite, and tackling a very big job, can the user equipment costs be reduced to the point that satellite communications becomes a part of the daily experience of a large portion of our population.

Consider that the total cost of a school terminal would be only $2800, as compared to $15,000-$25,000 for a terminal using channels on a current-day satellite. I fail to see how an amortized total cost of 36 cents per classroom-hour is, as Dlugatch states, "utterly out of line."

Furthermore, he apparently chose to ignore the statement on my last page, "While these costs indicate that TV education via space costs much less than by ground transmissions they do not necessarily imply a preference for TV over live teachers. In fact, since the space TV concept would cost a school less than 5% of a teacher's salary, the teachers could use TV extensively as an aid at little additional expense."

Dlugatch advises me to "revise downward my grandiose scheme" and try for something "feasible in a much nearer future." To be sure we can, and probably must, begin with much more modest capability and make it available sooner, and grow to the systems I describe. But as I indicated in my introduction, I set out to explore such very-high-capacity systems so that we would know where to aim our technology and understand the inherent potential in this class of service, not to advocate the systems themselves.

In the matter of the costs of programming, for which I assumed an average of $10,000 per hour, Dlugatch asserts that "the minimum cost is around $20,000 and some programs run as high as $100,000." True, some "Sesame Street" productions do cost up to $100,000. However, they use the finest of gold-plated studios and big-name script writers, and have a large number of highly paid celebrities as actors. By far the greatest number of documentaries and film clips, which are not so burdened, do cost around $10,000 per hour.

Moreover, education entrepreneurs who wish to document, say, an hour on "Indian History" can do so now at costs as small as $500 to $1500, as shown by work at Purdue and Oklahoma State. All they do is write an elementary script, get their students to gather material and function as actors, and hire any one of a number of small studios to provide lights, cameras, engineers, and the video production staff.

Demand for the vast capability of systems such as I postulated could create a whole new field of involvement and opportunity for educators (and their students, which is education at its best).

I agree that "economists, educators, and other soft science specialists" should collaborate on articles such as mine, and I invite Professor Dlugatch to explore with me some of the vast new possibilities which can be created by educational use of communications satellites such as those I have described.

Ivan Bekey
Chief, Advanced Concepts
Advanced Programs Office
NASA Office of Space
Transportation Systems

Appendix G

PRELIMINARY PROGRAM OF THE 1983 ANNUAL POWDER METALLURGY CONFERENCE AND EXHIBITION

Call For Papers

THE POWDER OF IMAGINATION

1983 Annual
Powder Metallurgy
Conference & Exhibition

May 1-4, 1983 □ New Orleans

Theme

"The Powder of Imagination" is the general theme for the 1983 Annual Powder Metallurgy Conference & Exhibition. Sponsored by the Metal Powder Industries Federation and the American Powder Metallurgy Institute, the conference will be held on May 1-4, 1983 at the New Orleans Hilton in New Orleans, Louisiana.

Authors are invited to submit abstracts for papers to be presented in the technical program and for In-Tech Workshops. Abstracts must be received before October 15, 1982 to be considered by the Program Committee.

Technical Program

Technical papers addressing all aspects of powder metallurgy from improvements in manufacturing practice to basic metallurgy are needed which support the general conference theme with emphasis on *productivity and diversification*. The following topic areas are suggested:

Productivity

- Improved powders of existing or new compositions
- New forming methods
- Improved forming control techniques
- Materials handling methods
- Production rate increases in current furnaces
- Improved sintering technique and control methods
- Faster or new de-lubing techniques
- Energy and atmosphere savings
- Equipment modification for improved productivity and quality
- Maintenance reduction techniques
- Quality evaluation and control techniques
- Materials and product standards
- Productivity and cost control techniques

Diversification

- Powders for new applications
- Materials developments (ferrous, non-ferrous, and specialty)
- Rapid solidification technology developments
- Unconventional shape forming techniques
- Unconventional sintering techniques
- High temperature sintering equipment developments
- High and full density process developments
- Welding and joining techniques for P/M
- New finishing techniques
- New products from conventional or unconventional technology
- New market opportunities

In-Tech Workshops

In addition to the regular technical program, abstracts may be submitted for In-Tech Workshops. Papers selected are those whose informational content and value are directed to the manufacturing segment of the industry or those that represent research and development in progress. Speakers will be allotted approximately one hour for presentation and discussion. Presentations can be concise and rely heavily on visual aids and can involve a more protracted discussion period with audience interaction. Suitability for publication in the conference proceedings will be determined by the Program Committee.

The following topics are suggested:

- New Products, Equipment and Technology
- Research and Development in Progress

MPIF APMI

Metal Powder Industries Federation • American Powder Metallurgy Institute

Yes. I would like to submit the following paper for Program Committee consideration at the 1983 Annual P/M Conference.

- ☐ Technical Program
- ☐ In-Tech Workshop Program

Return before October 15, 1982 with abstract to:

Program Committee
Metal Powder Industries Federation
105 College Road East
Princeton, New Jersey 08540 U.S.A.
Attn: Teresa F. Stillman

Title of Paper: ______________________________

____

____

Speaker/Author(s) ______________________________

____

____

Name (Speaker) ______________________________

Company ______________________________

Address ______________________________

City ______________________________

State (Province) ____________________ Zip ____________

Telephone ____________________

Other Conference Activities

Along with the technical program and In-Tech Workshops, the following conference activities are being planned.

- Special Panel Presentation and Discussion: Competitive Alternatives to P/M in Selected Applications (e.g. business machinery, mill products, automotive, electrical, superalloys, home appliances).
  Members of the panel will be invited speakers - each fully familiar with the specific subject matter. Contents of this session will not be published in order to promote in-depth presentations and open discussions. This session should be very useful to those concerned about the market share of P/M.
- Seminar: Applications of Automation to P/M Manufacturing — This special seminar will focus on automation, robotics and computerization and will be presented apart from the regular conference program.
- P/M Design Clinic — Oriented toward design engineers and users of P/M products, the clinic will serve as a pilot for similar clinics to be held on a regional basis.
- Exhibition — A vastly expanded trade exhibition of P/M parts, powders, equipment, suppliers and services.

For further information and correspondence to Program Committee contact:
Teresa F. Stillman
Technical Program Coordinator
Metal Powder Industries Federation
105 College Road East
Princeton, N.J. 08540 U.S.A.
(609) 452-7700 TWX: 510 685 2516

To Submit An Abstract

Complete the attached form and return with abstract (200-400 words) stating clearly the subject matter and objectives of the proposed paper. Also, please indicate the potential value of the topic to the P/M industry.

Deadline for submission of abstracts: October 15, 1982

Authors will be notified of the Program Committee's decision by December. Title of paper subject to editorial revision by Program Committee.

Proceedings: All technical program papers and selected In-Tech Workshop presentations will be published following the conference in "Progress in Powder Metallurgy, Volume 39." Abstracts may be edited and will be published in the Conference Guide distributed at the conference.

Program Committee:

Program Chairmen:
Kenneth E. Meiners
Battelle Memorial Institute
Harbhajan S. Nayar
Airco Inc.

Committee:
Earl A. Carlson
Amsted Research Labs
Randall M. German
Rensselaer Polytechnic Institute
Ronald C. Mowry
C. I. Hayes, Inc.
Robert A. Powell
Hoeganaes Corporation
Fred A. Schaa, Jr.
AC Compacting Presses, Inc.
John H. Tundermann
Huntington Alloys, Inc.
William J. Ullrich
Alcan Ingot and Powders
Raymond Waltenbaugh
IPM Corporation
Charles I. Whitman
Glidden Metals

In-Tech Workshops:
Sydney M. Kaufman
Ford Motor Company

LMSC-D889718

SPACE STATION PROGRAMS

ATTACHMENT 2
SUPPORTING DATA AND ANALYSIS REPORTS
VOLUME I

VOUGHT CORPORATION
SUBCONTRACTOR

Lockheed

VOUGHT CORPORATION

Post Office Box 225907 • Dallas, Texas 75265

2-19200/3L-1187B

25 February 1983

Lockheed Missiles and Space Company, Inc.
1111 Lockheed Way
Sunnyvale, California 94086

Attn: Mr. Don Smith
Mail Stop 0/61-87, Bldg. 529

Ref: (a) Lockheed letter dated 15 February 1983

Encl: (1) Teleoperator Maneuvering System Study Reports, Volumes I and II, dated 31 January 1983
(2) Performance Capability of TMS Based at Space Station, 6 pages

Dear Don,

The enclosed data are provided in partial fulfillment of Lockheed Missiles and Space Company, Inc. purchase order number FBS9S5210F with Vought for our support of your NASA/DOD Study, "Space Station Needs, Attributes and Architectural Options". These data are responsive to reference (a) requesting data by 1 March 1983.

We look forward to discussing these data with you at your earliest convenience to mutually identify final vugraphs and accompanying text which you may use in your April review for NASA.

Sincerely,

Ray French

Ray French
Manager-Teleoperator
Maneuvering System

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RF/df
encl.

cc: Mr. Steve Kayser (Encl. 2 only)
Mail Stop 0/78-20, Bldg. 56F

PERFORMANCE CAPABILITY OF TMS BASED AT SPACE STATION

The performance capability of TMS based at the Space Station is described in the following sections. The TMS configuration used in these analyses was a 15-foot diameter TMS with 6,713 pounds of bipropellant fuel (I_{sp} = 285 sec) and a basic inert weight of 4049 pounds (423 pounds are added for missions requiring a rendezvous kit). The TMS performance was determined from velocity requirements for the TMS to maneuver to circular orbit altitudes from a Space Station at 235 NM. The performance data reflect TMS return to the Station via a 160 NM altitude phasing orbit. Performance data for other Station altitudes with phasing 75 NM below Station show similar contours. Plane changes were accomplished such that total velocity required was minimized, that is, the plane change was optimally segmented between the two transfer burns. Hohmann transfer maneuvers were assumed.

PLACEMENT MISSIONS

The TMS performance capability for satellite placement missions is shown in Figure 1. As requested, the range of payload weights extends to 100,000 pounds and the 150 pound capability is highlighted. Plane changes capability approaches 10 degrees. Orbital altitude changes of approximately 1620 NM are possible with no plane change.

RETRIEVAL MISSIONS

The TMS performance capability for satellite retrieval missions is shown in Figure 2. If data and materials package retrieval consist of TMS leaving the Station with no payload and returning with payload, the capability shown in Figure 2 is applicable to this retrieval mission. Payload weight range to 100,000 pounds is shown and 150 pound capability is highlighted. Plane change capability is slightly greater than 9 degrees and retrieval missions can be performed from orbital altitudes of up to approximately 1460 NM above the Station. Note that TMS inert weight includes the additional rendezvous kit.

SERVICE, REPLACEMENT, INSPECTION MISSIONS

Each of the service, replacement, or inspection missions is characterized by payload weight being a constant for the entire mission. For

servicing, weight change due to data and materials package exchange and/or expendables replenishment is assumed to be zero. For replacement, deployed satellite weight is equal to weight of satellite retrieved. For inspection missions, no equipment/sensors are assumed to be jettisoned.

The TMS performance capability for service, replacement, inspection missions is shown in Figure 3. Payload weight range to 100,000 pounds is shown and 150 pounds is highlighted. Plane change capability is on the order of 9 degrees and maximum orbital altitude change is approximately 1460 NM. Note that TMS inert weight includes the additional rendezvous kit.

TMS DELTA VELOCITY CAPABILITY

The velocity capability of the TMS is shown in Figure 4. Capability is shown as a function of propellant weight for the TMS and for the TMS plus a tanker module. The tanker module is a TMS spaceframe with thermal protection system and propellant tankage and lines. The tanker module has an inert weight of 1923 pounds and allows the TMS to double the usable propellant weight to 13,426 pounds (6,713 pounds in tanker module). For no payload and an assumed specific impulse of 285 seconds, the TMS can deliver up to 8,964 ft/sec velocity and the TMS plus tanker module can deliver up to 10,803 ft/sec.

Shown for comparison is the velocity capability of the TMS if specific impulse is 300 seconds. TMS deliverable velocity is 9,436 ft/sec and TMS plus tanker module is 11,372 ft/sec.

CONCLUSIONS

The TMS can provide a great benefit to the Space Station by extending the reach of the Station to altitudes in excess of 1700 NM and to orbital planes up to 10 degrees different from the Station. The capabilities inherent in providing these remote operations are also compatible with providing similar capabilities in close proximity to the Station without requiring manned EVA. The TMS should be considered an irreplacable adjunct for assembly, logistics support, and full utilization of the manned Space Station capability.

Figure 1 TMS Performance Capability Station-Based Placement Missions

- Phasing Altitude 75 NM Below Station
- TMS - Inert = 4,049 lb
  Propellant = 6,713 lb
  Isp = 285 sec

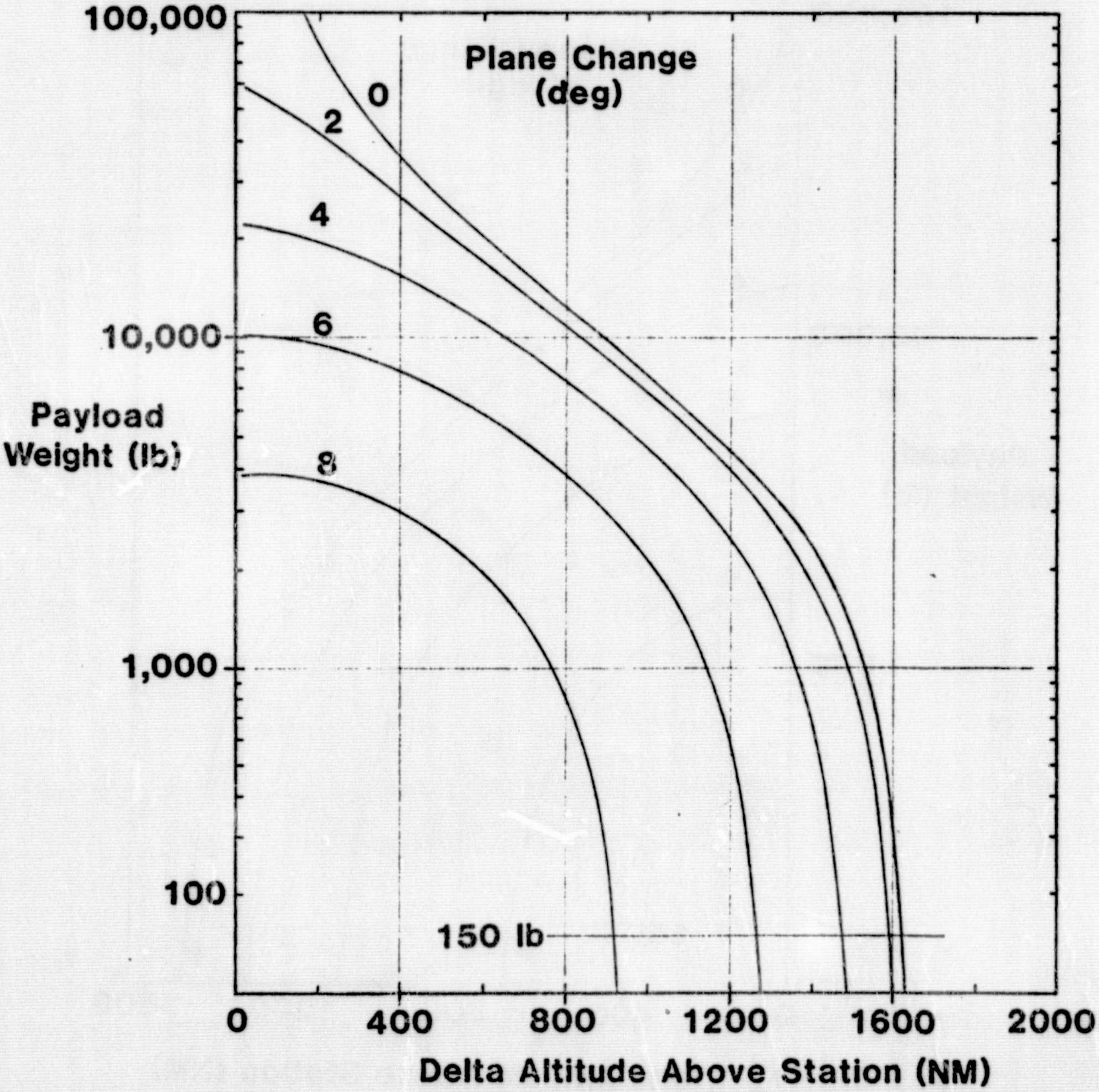

Figure 2 TMS Performance Capability Station-Based Retrieval Missions

- Phasing Altitude 75 NM Below Station
- TMS - Inert = 4,472 lb
  Propellant = 6,713 lb
  Isp = 285 sec

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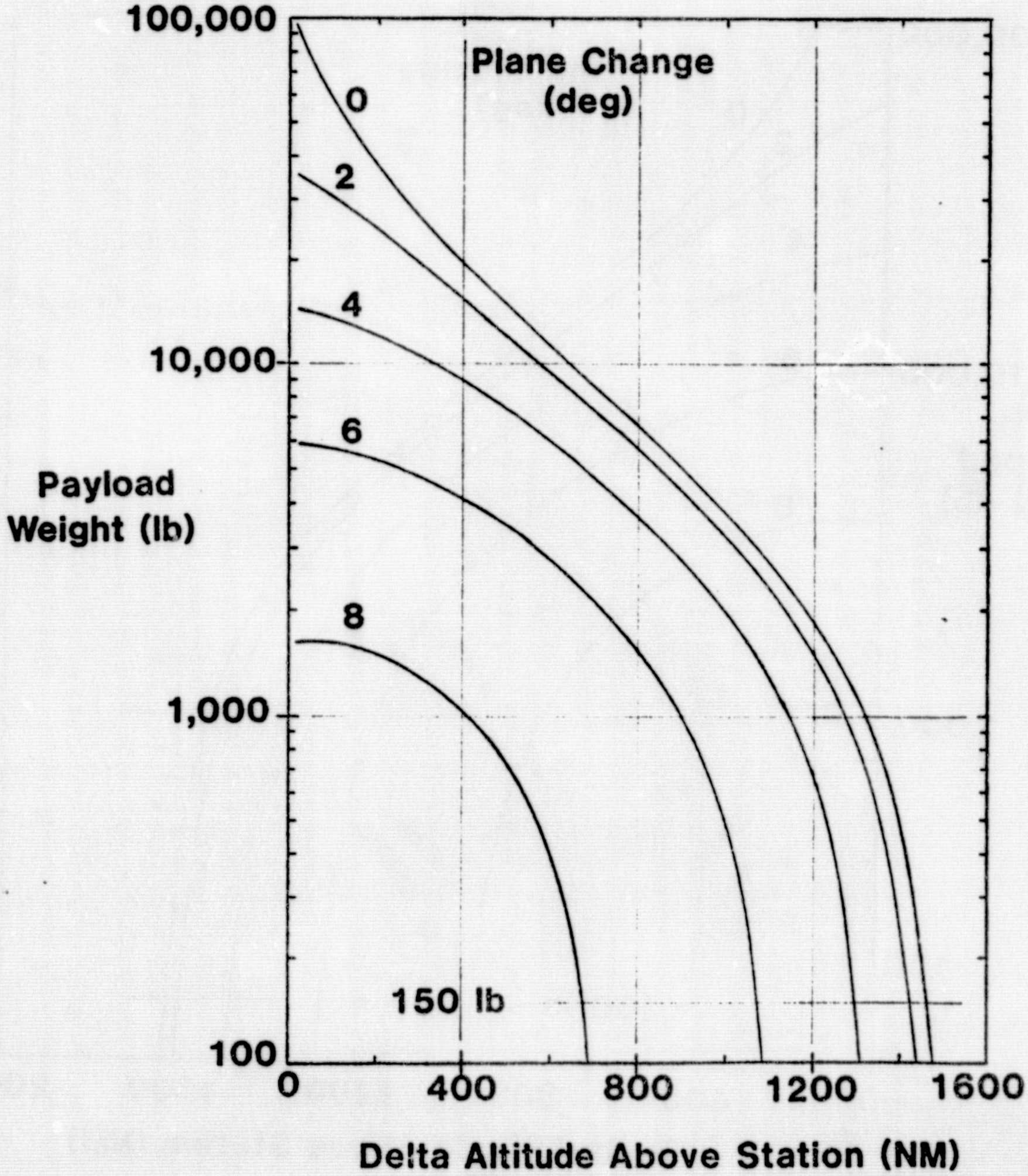


Figure 3 TMS Performance Capability Station-Based Service, Replacement, Inspection Missions

- Phasing Altitude 75 NM Below Station
- TMS - Inert = 4,472 lb
  Propellant = 6,713 lb
  Isp = 285 sec

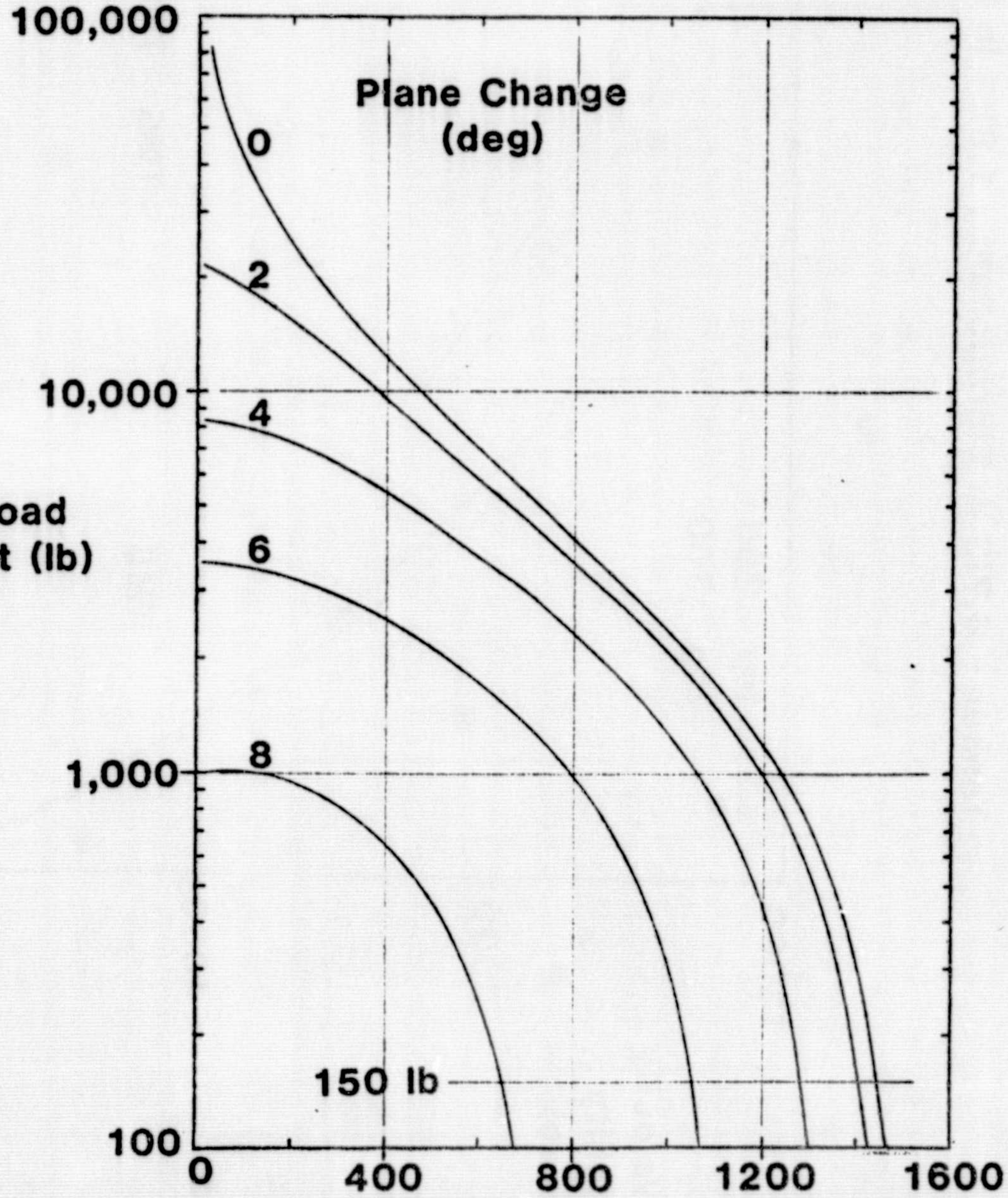
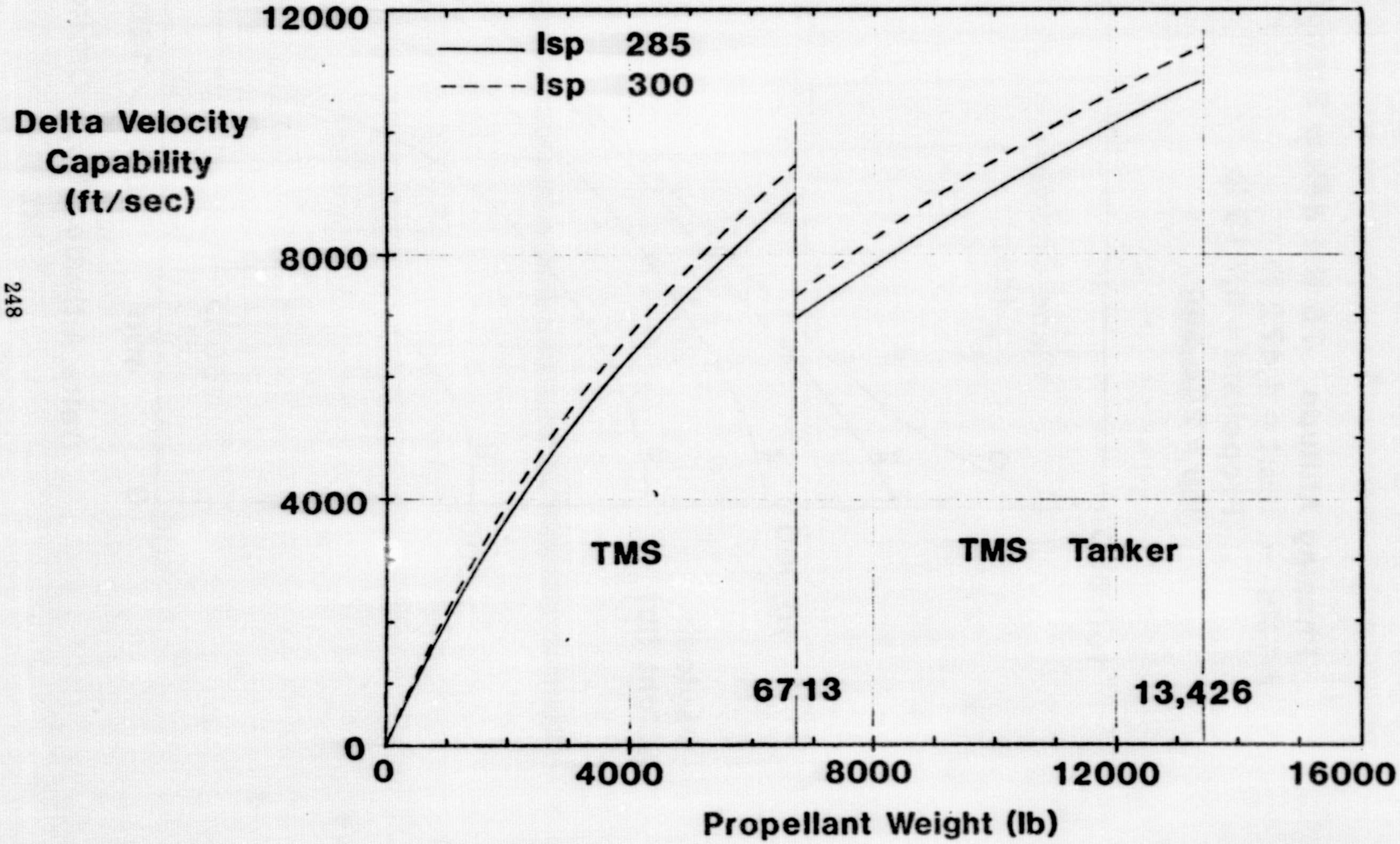


Figure 4 TMS Delta Velocity Capability (No Payload)

- TMS - 6,713 lb Bipropellant, 4,049 lb Inert
- Tanker - 6,713 lb Bipropellant , 1,923 lb Inert



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SPACE STATION PROGRAMS

ATTACHMENT 2

SUPPORTING DATA AND ANALYSIS REPORTS

VOLUME I

LIFE SCIENCES - DORNIER SYSTEM

Lockheed

DORNIER

Dornier-System GmbH - Friedrichshafen

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Dornier-System GmbH · Postfach 1360 · 7990 Friedrichshafen 1

Lockheed Missiles and Space Co.,
Inc.
Attn.: Dr. K.J. Forsberg,
ORGN/61-87, BLDG/577N
P.O.Box 504

SUNNYVALE, CA. 94086

U.S.A.

Bearbeiter: Dr. A.I. Skoog

Telefon-Durchwahl:
(07545) 8- 3920

Ihr Zeichen	Ihre Nachricht	Unser Zeichen	Friedrichshafen,
		ERR-Sk/ba	18.02.1983

Subject: Dornier System Inputs to NASA Space Station Study

Ref.: Visit of your Mr. Fred Hekking to Dornier System on 10 December 1982.

Dear Dr. Forsberg,

In accordance with the agreements at the above referenced meeting we have the pleasure to submit you following inputs for your Space Station Study under NASA contract:

- Life Sciences and Life Support Development Experiments on a Space Station
  (TN-SSS-DS-005; 16.02.1983)

This document has been prepared under ESA contract to support you with information on relevant European aspects and technologies for a Space Station.

We are looking forward to hear from you and will be glad to answer any questions you may have.

Sincerely yours,

Dornier System GmbH

G. Rausch　　Uebelhack

i.V. G. Rausch　　i.A. Dr. Uebelhack

Enclosure

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copy: Mr. Fred Hekking (letter only)

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DORNIER SYSTEM

Participation in NASA Space Station Study

TITLE: LIFE SCIENCES AND LIFE SUPPORT DEVELOPMENT EXPERIMENTS ON A SPACE STATION
TITEL:

DOCUMENT NO.: TN-SSS-DS-005
DOKUMENT NR:

ISSUE NO.: -
AUSGABE NR:

ISSUE DATE: 16.02.1983
AUSGABEDATUM:

PREPARED BY: Dr. A.I. Skoog
BEARBEITET:

COMPANY: Dornier System GmbH
FIRMA:

CONTRACT NO :

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Å. Ingemar Skoog

PROJECT MANAGER
PROJEKTMANAGER

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TABLE OF CONTENTS

1. INTRODUCTION

Microgravity research plays a very important role in the European Space Programme and a series of major life sciences payloads are planned for the 1980's. Except for the German D1 mission the missions presently foreseen are all organized by the European Space Agency (ESA), e.g. the First Spacelab Payload on STS-9 and EURECA, with experiments from the various member states of ESA. Some ESA payloads like Biorack and the SLED will be flown on the German D1 mission.

The present ESA planning for life sciences payloads and the development of necessary equipment and technologies therefore in the 1980's, together with trends for the 1990's, forms the basis for the definition of a potential use of a Space Station for life sciences research and technology development. As for trends for the 1990's important inputs and ideas have been gathered by means of a German users workshop and discussions with various scientist and from Dornier inhouse experience in life sciences research and the development of advanced life support systems.

The life sciences users community has shown a very strong interest in the potential use of a Space Station for 1990's. Their first identification of tentative experiments and likely continuations of scientific investigations contain a very precise and detailed description of requirements and necessary equipment. This enables an elaboration of fairly well defined mission criteria, Space Station requirements and mission planning.

This study has been performed based on available ESA planning and payload information, German planning and the results of discussions with the German life sciences community and the first "workshop for potential users of future Space Platforms". Furthermore our inhouse Dornier System experience of advanced and ecological life support systems has been used. The relevant information on ecological life support systems have been elaborated in cooperative studies between Dornier System and Hamilton Standard.

One of many definitions used for the subdisciplines in space related life sciences is:

- Gravitational Biology,
- Radiation Biology,
- Exobiology,
- Human Physiology and Medicine,
  and
- Life Support Systems.

In this study Human Physiology and Medicine, and Life Support Systems are discussed separately. This is due to their character as spacecraft subsystems and crew support in their applied from in the post experimental stage.
Therefore under the general heading life sciences are meant gravitational biology, radiation biology and exobiology with their character of fundamental sciences research.

Concerning bioprocessing, this is regarded as material processing due to its direct commercial application.

2. EUROPEAN ACTIVITIES IN THE 1980's

The Life Sciences activities during the 1980's in Europe are characterized by the ESA Microgravity Research Programme and the therein foreseen flight opportunities (e.g. First Spacelab Payload (FSLP) and EURECA) (Fig. 2.1), and national missions like the German D1. The various research elements in these programmes require the development and initial use of a large number of hardware items. This equipment will then be available as proven hardware, once the Space Station will become available for more elaborate life sciences and human physiology research, and applied space medicine in the early 1990's.

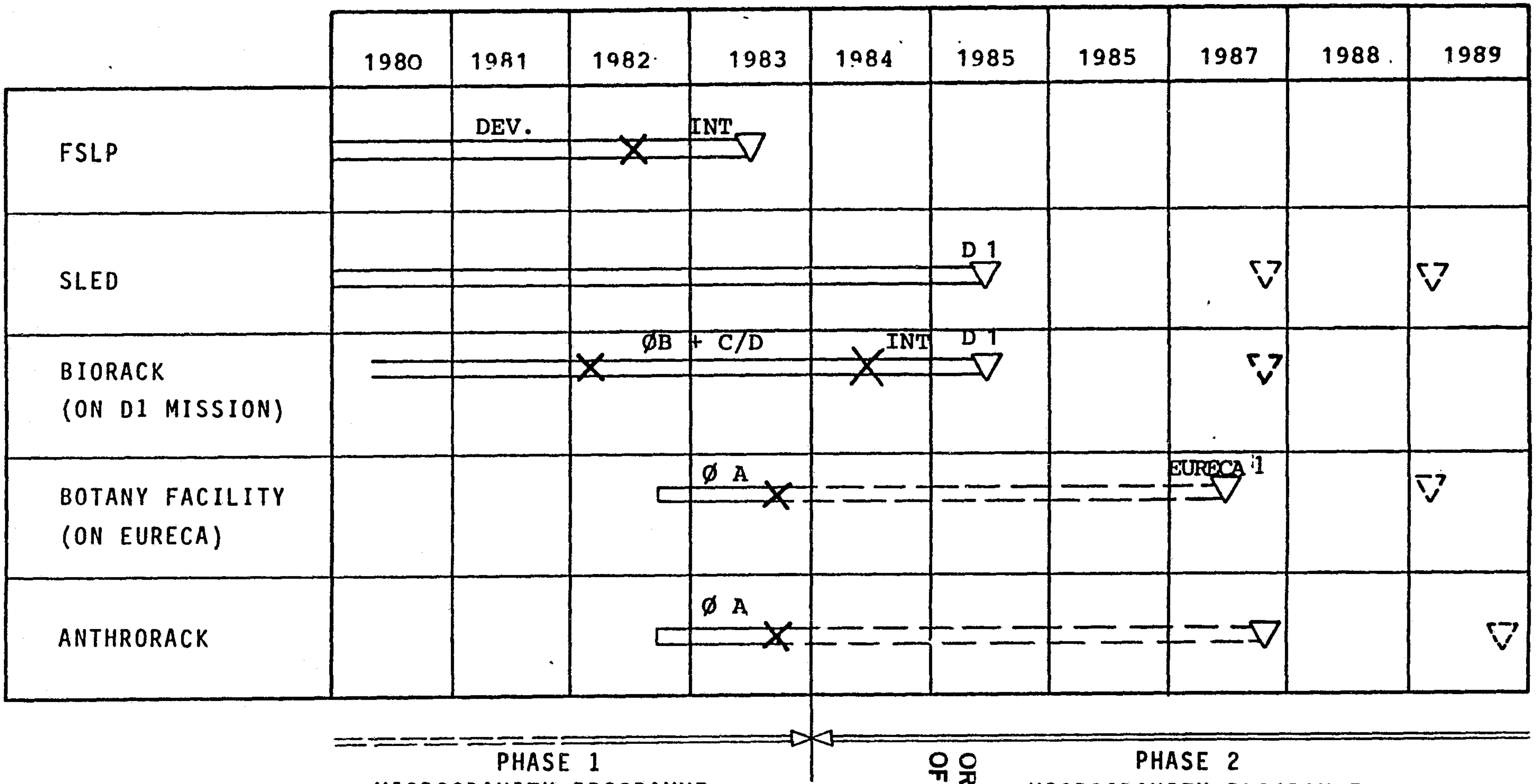

Fig. 2.1: EUROPEAN LIFE SCIENCE ACTIVITIES

▽ = POTENTIAL REFLIGHT OPPORTUNITY

2.1 Life Sciences

The major life sciences research facilities in the ESA Microgravity Research Programme are the:

- FSLP Experiments,
- BIORACK, and
- BOTANY FACILITY.

These multiuser facilities will be flown once or several times before the initial Space Station.
The general scientific goals of the European and ESA programmes are to study:

- transport processes and mechanicsms at cellular level,
- role of gravity for orientation purposes,
- gravity effects on development/genetics,
- processing at gravity vector information,
- adaptive processes to microgravity,
- radiation responses, and
- genesis of life.

European life sciences experiments on the First Spacelab Payload (FSLP) to fly on STS-9 in September 1983 are:

- the influence of exposure to hard space environment on living matter at cellular level (microorganisms and biomolecules), and
- advanced Biostack experiment to determine the radiobiological importance of HZE particles.

In addition US experiments on e.g. geotropismus will also be part of the FSLP. The Biostack experiment is a continuation of European experiments flown on Apollo 16 and 17, and Apollo-Soyuz.

The BIORACK is a multi-purpose experiment facility to enable biological investigations to be carried out on board Spacelab on such life forms as plants, tissues, cells, bacteria and insects (Fig. 2.2). Its purpose is to determine the effects of zero-g and the space radiation environment on the behaviour of these life forms. The BIORACK will also carry facilities for performing 1-g reference measurements in order to allow for a discrimination between zero-g and radiation effects.

The BIORACK will contain the following equipment:

- Incubator with dynamic range 18-30 $^{\circ}$C, controlled to $\pm$ 0.5 $^{\circ}$C.
- Incubator with dynamic range 30-40 $^{\circ}$C, controlled to $\pm$ 0.5 $^{\circ}$C.
- Cooler compartment operating at approximately 4 $^{\circ}$C.
- Freezer compartment operating at -15 $^{\circ}$C.
- Glove box.
- Standardized experiment containers.
- 1-g centrifuges.
- Auxiliary investigation equipment (microscopes, cameras etc.).

The ESA BIORACK consists of a single SL RACK (Fig. 2.2) and it is planned to be flown for the first time on the German D 1 mission in 1985.

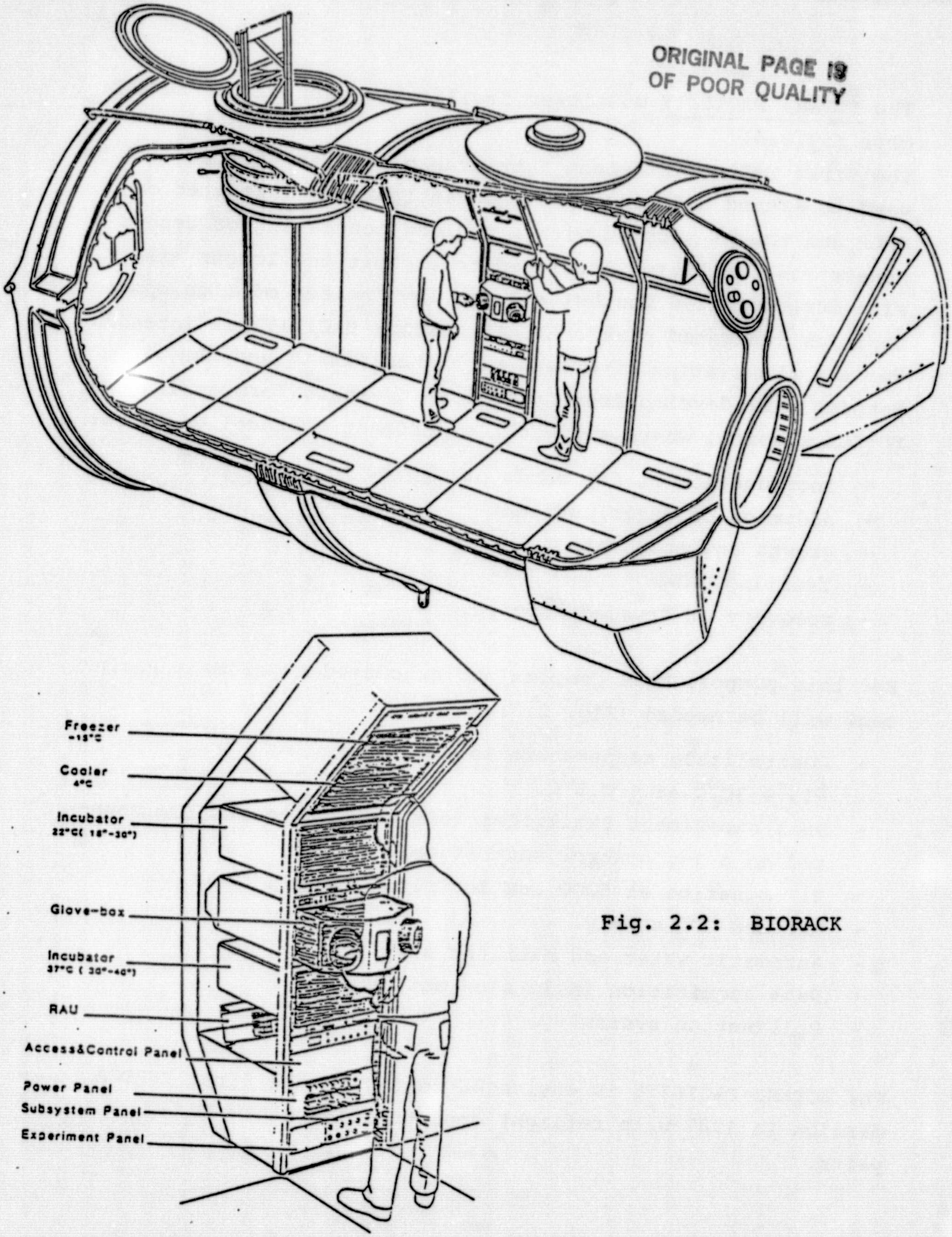

Fig. 2.2: BIORACK

The BOTANY FACILITY multiuser facility is part of the EURECA core payload.
The first EURECA (European Retrievable Carrier) flight will be used to extend and consolidate investigations initiated on FSLP and the D1 mission with a payload consisting of second generation facilities developed to exploit the longer mission duration (2-6 months) and the low "noise" mission opportunities (unmanned platform). The BOTANY FACILITY is intended for the observation of growth of higher plants and fungi. Samples will develop from inert form to inert form during the EURECA mission, where a typical experiment protocol could be:

- introduction of dry seeds or spores in orbit,
- addition of water/nutrient,
- growth and observation,
- fruiting, and
- recovery of dryseeds/spores.

For this purpose more complex and automated experiment equipment will be needed (Fig. 2.3):

- Controllable temperature in the range $\pm 15 \div 30^{\circ}C$ at $\pm 0.5^{\circ}C$.
- Dual experiment facilities (one at micro-g and one mounted on a 1-g control centrifuge).
- Illumination at 5000 lux for plant growth.
- Air and CO_2 supply.
- Automatic water and nutrient supply.
- Data acquisition incl. slow motion video.
- Pollination system.

The BOTANY FACILITY is envisaged to fly on the first EURECA mission in 1987 with reflight opportunities every 1.5-2 years.

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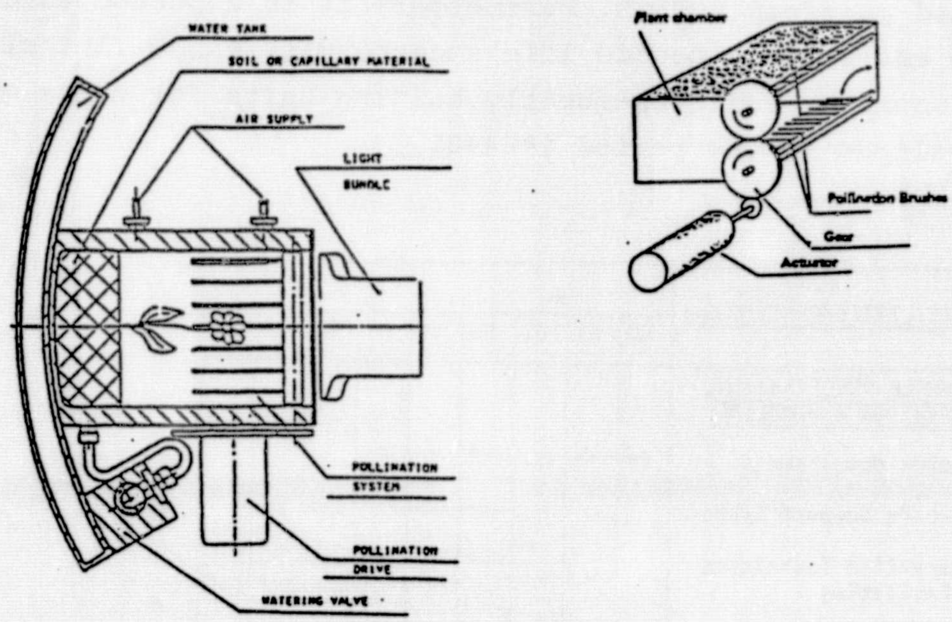

PLANT FACILITY
CULTURE CHAMBER FOR PLANTS

Fig. 2.3: BOTANY FACILITY

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The development of required equipment for BIORACK and BOTANY FACILITY is supported by the ESA Technology Research Programme (Fig. 2.4). It is to be noted that the facilities intended for flight in 1987-88 in Fig. 2.4 are automated facilities for the unmanned platform EURECA. Furthermore it is expected that by the end of this decade life science missions will include small mammals, and subsequently holding units for these must be developed in the period 1984-89.

FACILITIES/FUNCTIONS	80	81	82	83	84	85	86	87	88
BIOSAMPLE PRESERVATION, OBSERVATION & HANDLING									
Glovebox development	++	++++	xxxx	****	oooo	F			
Mini-Life Support Systems				--+++	+xxx	****	oooo	F	
Preservation Techniques and Facilities			--	--+	++++	****	oooo	F	
					++++	+++++	xxxx	****	oooo
Observation Facilities				--+++	+xxx	****	oooo	F	
Containment and Transport Facilities			--	--+	++++	****	oooo	F	
					-----	++++	xxxx	****	oooo
Dynamic Cooler		----	++++	++++	xxxx	****	oooo	F	
LIFE SCIENCE CONTROL EXPERIMENT FACILITIES									
One 'g' centrifuge	--	---	++++	+***	oooo	F			

KEY
----- Definition
+++++ Critical Items B.B.
xxxxx B.B. System
***** EM
ooooo Operational Hardware
F Flight Opportunity

Fig. 2.4: ESA Life Science Facility Development Plans

2.2 Human Physiology in Space

A major role in the ESA Microgravity Research Programme during its second phase in the latter part of this decade will be given to the human physiology research and medicine in space. The planned activities are the:

- FSLP Human Physiology Experiments,
- SLED and Improved SLED, and
- ANTHRORACK.

The main scientific objectives for the European human physiology research programme are to study:

- man under microgravity conditions,
- inflight general symptomatology,
- cardiovascular changes,
- tolerance to gravitation,
- fluid loss,
- detraining,
- calcium loss,
- neurosensory changes, and
- space sickness.

The first European astronauts will be on board the FSLP in order to perform the following human physiology experiments:

- mass discrimination between equal objects of different mass,
- blood samples for hormonal analyses,
- ballistocardography (accelerometers taped to subject will determine stroke volume etc.),
- electrophysiological tape recorder testing (ECG, EEG, EOG, and EMG),
- central venous pressure measurement,
- lymphocyte proliferation, and
- vestibular/sensori-motor function research.

The FSLP is the first SPACELAB and European astronaut mission to take place in September 1983. This mission (STS-9) is a combined US/European mission.
The SLED (Fig. 2.5) experiment objectives are to study:

- the response mechanisms of the human sensory balance system to inertial forces in the abscence of earth gravity forces,
- the interactions between balance (inertial), visual, audio and other physical sensations, and
- ways of alleviating the problems of space sickness.

The SLED will fly the first time on the German D1 mission in 1985.

An Improved SLED with a gimballed seat, additional acceleration profiles at increased levels is presently being analysed for a potential operational use about 1986-88.

ANTHRORACK is a human physiology research facility for Spacelab adapted to fit a double-rack configuration. The scientific goals are to study human physiology during microgravity in the field of:

- cardiovascular and pulmonary function and adaptation,
- metabolic processes and adaptation, and
- sensori-motor function and adaptation.

The ANTHRORACK facility will consists of service elements and experiment specific equipment:

- Service Elements
  . Data handling subsystem, computer, keyboard, screen, data storage
  . Blood and urine sampling kits and storage

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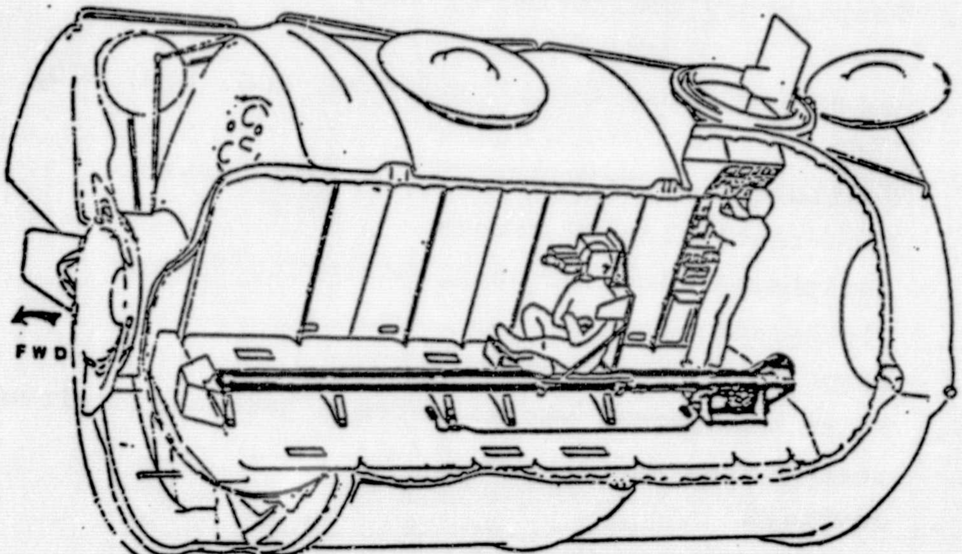


Fig. 2.5: ESA SPACELAB SLED

- Freezer, cooler
- Centrifuge
- General storage for equipment, waste disposal
- Voice recording system
- Respiratory monitoring system, with gas analyses
- General purpose amplifiers (EMG, EOG, EEG, ECG, ESG)
- Monitoring ambient temperature and pressure
- High-resolution TV camera
- Peripheral blood pressure measuring system
- Plethysmograph
- Ergometer, dynamometers
- Pulse generator, visual pattern generator, visual task generator
- Joystick

- Experiment Specific Equipment
  - Ocular pressure measurement device
  - Ophtalmoscope
  - Central venous pressure measurement
  - Ultrasound techniques
    - tissue compliance
    - central and peripheral blood flow
    - blood density
    - cardiac output by echocardiography
  - Eye movement recording via imaging techniques
  - Photo-optical sensor
  - Heart rate laser sensor
  - Laser doppler skin blood flow
  - Rotating chair

- Linear motion device (oscillations and short range)
- Posture platform
- Stimulation/recording equipment for active/passive arm movements.

The preliminary planning foresees the first mission of ANTHRO-RACK in 1987.
The human physiology research programme is supported by the development of critical hardware items within the framework of the ESA Technology Research Programme (Fig. 2.6).

To be considered, when planning for future human physiology research, are also the results of French tests onboard the Russian Salyut space station which started in 1982 (e.g. ultrasound cardiography and posture platform experiments).

2.3 Life Support

The present SPACELAB life support system is using the same open-loop technology as used in the SHUTTLE ORBITER. Systems of this type are adequate for mission durations of up to 2-3 weeks for crew sizes in the order of 4-7 persons. For longer missions and/or crews regenerable systems for:

- CO_2 removal,
- water reclamation, and
- oxygen recovery

will become inevitable, and various concepts on a physico-chemical basis have already been developed in the U.S..

FACILITIES/FUNCTIONS	80	81	82	83	84	85	86	87	88
SPACE MEDICINE FACILITIES									
Breath to Breath gas analyser			--	--++x	x***	oooo			
Ultra-Sound Imaging Instrumentation				-----	++++	++++	xxxx	****	oooo
Non-Invasive Body Function Monitoring				-----	--++	++++	++++	xxxx	oooo
Thermographic monitoring				-----	++++	xx**	oooo	F	

KEY

-----	Definition	*****	EM
+++++	Critical Items B.B.	ooooo	Operational Hardware
xxxxx	B.B. System	F	Flight Opportunity

Fig. 2.6: ESA Space Medicine Facilities Development Plan

They will be flown on various SL missions as experiments before final implementation in an improved SHUTTLE/SPACELAB or in the SPACE STATION.
Europe will make use of these new regenerable technologies for improved and enhanced SPACELAB capabilities, as has already been studied in the SPACELAB Follow-On Development Programme.

In parallel here to various types of experiment dedicated life support systems for plants, lower vertebrates and small mammalians are under development to support the various types of life sciences experiments planned in Europe for the 1985-89 period.

Initial efforts to investigate advanced life support systems of ecological/biological type to close the carbon loop (food supply), Fig. 2.7, have been undertaken in Europe and the U.S. in the last years (e.g. the cooperative effort Dornier System/ Hamilton Standard).
This effort will during this decade be concentrating on feasibility studies, investigations of specific development issues and flight experiments to prove the viability of selected detailed conceptual designs or to provide information on basic scientific issues. This in order to prepare for large scale testing on board a Space Station in the 1990's.

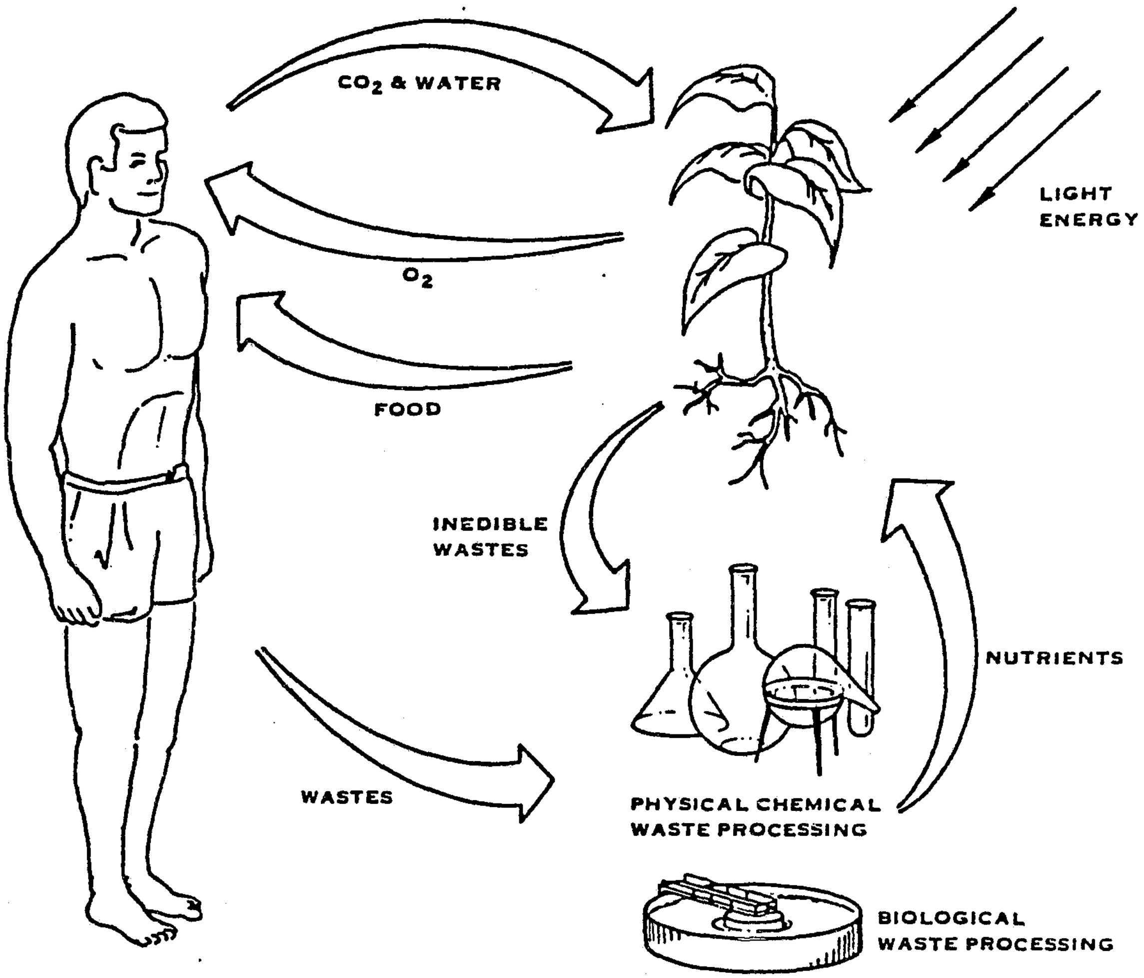


Fig. 2.7: BIOLOGICAL LIFE SUPPORT

3. LIFE SCIENCES IN THE 1990's

3.1 Objectives

Two of the most important characteristics in life sciences research are the relatively slow biological processes, and the high complexity and less predictable course of the experiments. This implicates long durations for the experiments and an active involvement of man in their performance as an experimentor and sometimes as a test subject as well. This is also why the life sciences community shows such a strong interest in the use of future Space Stations.

The Space Station will provide new capabilities like:

- long term missions with crew-changes about every 90 days,
- larger crews,
- higher power, and
- more space.

With these new opportunities some of the most hampering limitations for the Shuttle/Spacelab use would be removed and new mission scenarios for life sciences research in the 1990's can be depicted. New ideas of potential experiments and their related equipment have been gathered through close contact with the life sciences community in Europe, mainly in Germany.

Following major scientifical topics have been identified as likely candidates for space research in the 1990's.

- Gravitational Biology
  . Gravity Detecting Mechanisms.
  . Processing of Gravity Vector Information.
  . Cell Differentiation.
  . Genetics and Reproduction.
  . Embrogynesis and Organogenesis.
  . Adaptation to Microgravity
  . Combined Effects (e.g. with Radiation and Biological Rythm).
- Radiation Biology
  . Genetics.
  . Cell Differentiation.
  . Radiation Protection.
  . Combined Effects.
- Exobiology
  . Origin of Life.
  . Survival of Living Specimen in Space.
  . Interplanetary Transfer of Life.

3.2 Mission Drivers

The major parameters for identification of mission drivers are:

- mission duration,
- gravity level,
- radiation, and
- crew involvement.

Mission duration requirements range from about a week up to several years for the various mission objectives listed above. The primary effects of micro-gravity or radiation can be detected in general within less than a week of exposure to the space environment, but secondary or genetic effects can only be investigated through multi-generation tests in space i.e. by means of a Space Station. This requires the possibility to cultivate plants and breed animals over several generations in space.

The mission driver as for gravitational conditions is the gravitational biology, which in general requires an environment of less than 10^{-4} g. Concerning radiation, the radiation biology experiments involve exposure to the cosmic radiation mainly the HZE-particles and the heavy ions. Of particular interest is also the combined effect of microgravity and cosmic radiation, which requires a controlled microgravity environment. In order to exactly relate the results of various experiments, in particular those which could have combined effects, to the influence of a particular characteristic of the space environment, most scientists require reference centrifuges for plants and animals.

A crew involvement is required for the execution of most mission objectives, but in particular for the gravitational biology ones. Certain experiments involving animals, especially primates, require an extensive crew participation.

3.3 Equipment

A preliminary list of major equipment for the defined objectives has been established based on the scientific requirements.

- Gravitational Biology Experiments
  - Incubators for microorganisms, plants, and lower vertebrates.
  - Holding facilities for plants and animals (lower vertebrates and smaller mammalians, later primates).
  - Cytological Laboratory.
  - Development-physiological Laboratory.
  - Centrifuges for sample analysis.
  - Centrifuges for plants and animals (O-1 g and 1 g-reference centrifuges).
  - Collers/Freezers.
- Radiation Biology Experiments
  - Radiation measuring devices.
  - Incubators and laboratory equipments as for Gravitational Biology Experiments.
- Exobiological Experiments
  - Facilities for space environment exposure (vacuum, UV, HZE, extreme temperatures).
  - Radiation measuring devices.
  - Incubators for microorganisms.
  - Cytological Laboratory.

Some of this equipment like incubators, holding facilities for plants and animals, and centrifuges are under development in Europe (FSLP and D1 missions) and in the U.S. (Life Sciences Laboratory Equipment, LSLE, and Life Sciences Flight Experiments Program, LSFEP). New and improved versions already tested in space will be available in time for the early Space Station operations.

Other equipment like e.g. cytological and development physiological laboratories are still to be developed and tested.

3.4 Space Station Relevance

The analysis of mission criteria for the life sciences disciplines (Table 3.1) shows as major driving requirements for the utilization of a Space Station the:

- microgravity : $< 10^{-4}$ g for some experiments,
- mission duration : week up to several years, and
- crew involvement : High to medium; as experimentor and test subject.

The mission duration is beyond what can be achieved with the present (1 week) and planned enhanced (3 weeks) capability of the Shuttle/Spacelab. In the 1990's mission durations of months and years will be mandatory in order to investigate e.g. generic effects of microgravity and cosmic radiation. As for species like microorganisms, plants and insects the long term missions could be flown on unmanned platforms like EURECA. As for animals (lower vertebrates and mammalians) manned stations are inevitable, the longer the mission the stronger is the requirement of the presence of man to handle the test subjects (e.g. for several generations).

Furthermore the scientific experiments and investigations will become more and more sophisticated and complex in the future as the result of a logical evolution of the scientific goals and available means. This will make automation of experiment programmes more and more difficult and very expensive.

Table 3.1: MISSION CRITERIA FOR LIFE SCIENCES

MISSION CRITERIA / RESEARCH OBJECTIVE	COSMIC RADIATION	MICRO GRAVITY	VACUUM	CONTROLLED ATMOSPHERE	MISSION DURATION	CREW INVOLVEMENT	INCLINATION & ORBIT	TEST SUBJECTS				TEST PLATFORM		REMARKS
								MICRO-ORGANISMS	PLANTS	ANIMALS	CREW	SPACE STATION	UNMANNED FREE FLYER	
GRAVITATIONAL BIOLOGY	(Controlled)	$<10^{-4}$g	-	X	1week up to several years	high	Standard	X	X	X	X	X	(X)	Some experiments can be automated for unmanned platforms. Radiation levels to be controlled to determine combined effects
RADIATION BIOLOGY	X	$\sim 10^{-3}$g	-	X	1week up to several years	medium	57^{o}, 400km	X	X	X	-	X	X	Gravity level controlled to determine combined effects. Radiation: HZE and heavy ions.
EXOBIOLOGY	X	$\sim 10^{-3}$g	X	-	1week up to years	low	Standard	X	-	-	-	X	X	Gravity level controlled to determine combined effects, Radiation: Solar,UV Add. crit. ext.temp.

A potential limitation on a manned Space Station is the microgravity environment for gravitational biology. If the station is of an operations character some interference with the microgravity experiments could occur. Countermeasurements are detailed mission planning and dedicated research modules or stations.

3.5 Mission Implementation

Based on the mission objectives and the required equipment, a tentative schedule for the implementation and evolution of the life sciences research programme on a future Space Station has been established (Table 3.2).

With an Initial Space Station available around 1990, some equipment will be available through previous research activities in the 1980's (e.g. incubators, holding facilities and centrifuges). Other equipment like work station and laboratories will have to be developed for the scientific programme planned for the Space Station.

The growing use of animals and increased mission durations will make it necessary to implement a separate Animal Holding Module outside research and habitable areas of the station.
Ultimately a dedicated module for a Life Sciences Research Laboratory will become necessary in the latter part of the decade. The Animal Holding Module could be a part of this module.
Typical Space Station requirements for the Life Sciences research have been elaborated based on requirements for hardware presently under development and anticipated trends for hardware to be used on a Space Station (Table 3.3).

Table 3.2: LIFE SCIENCES TIME PHASING

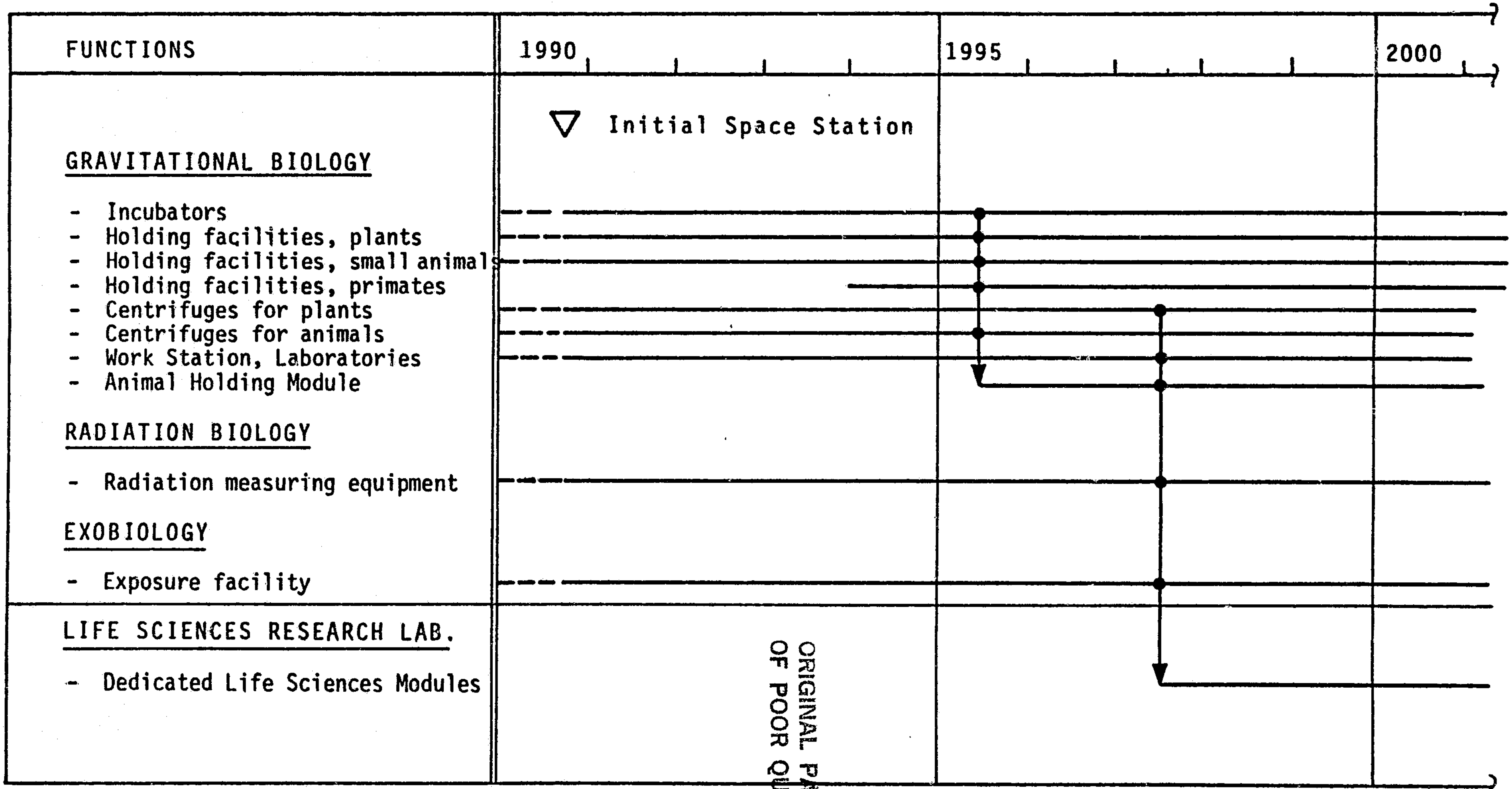


Table 3.3 : TYPICAL SPACE STATION REQUIREMENTS FOR LIFE SCIENCES

RESEARCH OBJECTIVE / SPACE STATION REQUIREMENTS	MISSION DURATION	MICRO-GRAVITY	MASS	VOLUME	POWER	CREW TIME	REMARKS
	DAYS	g	kg	m^3	kW	hrs/d	
GRAVITATIONAL BIOLOGY	8-60	$<10^{-4}$	25-100	0.1-0.5	0.1-1	0.5	CONTROLLED RADIATION LEVEL GENERAL REQ.
	8-90					1-2	
	30-180		100-300	1-2	0.1-1	0.5	REFERENCE CENTRIFUGES
						1-2	
	1-2 years		500	3-5	1-3	1-2	LARGER ANIMAL HOLDING FACILITIES
			300-600	2-3	1-3	1-2	DOUBLE RACK RESEARCH FACILITIES
RADIATION BIOLOGY	8-60	10^{-3}	25-100	0.1-0.5	0.1-0.5	1-2	CONTROLLED GRAVITY LEVEL
	1-2 years or more						
EXOBIOLOGY	8-365	10^{-3}	25-100	0.1-0.5	0.1-0.2	0.5	SOLAR, UV RADIATION. VACUUM. EXTREME TEMPE-RATURE
	1-5 years						
LIFE SCIENCES RESEARCH LAB	90-	10^{-3} to 10^{-4}	10.000-12.000	60-70	5-7	TBD	COULD INCLUDE ANIMAL HOLDING MODULE

4. HUMAN PHYSIOLOGY AND MEDICINE IN THE 1990's

4.1 Objectives

With a permanent presence of man in space, increasing crew sizes and prolonged missions a systematic research on the reaction and adaptation of man to microgravity and radiation will become a major activity on the Space Station.

The adaptation to microgravity and the possibility to perform daily routine work outside the pressurized modules will become a key issue as to the long term planning for Space Stations and operations in space.
The long term missions with Shuttle revisits every 90 days or even less also call for the development of adequate crew health care and medical support.

Necessary research objectives are:

- Human physiology
  - Cardiovascular functions,
  - Respiration kinetics,
  - Vestibular functions,
  - Metabolism, homone balance and immune system changes,
  - Changes in bones and muscles,
  - Long term effects of space radiation,
  - Fluid and electrolyte changes, and
  - Psycology and human behavior.

- Medicine
  - Diagnostic equipment development,
  - Responses to pharmaceuticals,
  - Research on invasive treatment procedures,
  - Health care/exercise equipment, and
  - Therapeutic capabilities for e.g.
    bonefracture
    burns,
    bleeding wounds,
    toxication,
    decompression,
    dental care,
    contusions, and
    acute surgical situations.

4.2 Mission Drivers

The principle mission driver is the presence of man on the Space Station.
The results of the research activities in human physiology in the 1980's and more intensively onboard the Space Station will set the final requirements for crew stay time, radiation protection measures, working capabilities and safety precautions.

The possibilities to develop adequate medical care and therapeutic procedures will have an influence on the safety concept and emergency procedures of the Space Station as it will grow. With increasing crewnumbers and mission durations the likelihood of an accident between Shuttle revisits will increase. Adequate medical treatment opportunities will therefore reduce the necessity of costly Shuttle emergency flight capabilities.

4.3 Equipment

The preliminary list of major equipment for the defined research objectives has been established based on tentative scientific and operational medicine requirements.

- Human Physiology
  - SLED, Long SLED.
  - Human Centrifuge (radius ∿ 10 m).
  - Rotating Chair.
  - Posture Platform.
  - Ergometer.
  - Respiratory Monitoring System and Gas Analysis.
  - Ultrasound Measuring Devices.
  - Peripheral Blood Pressure Measuring System.
  - Plethysmograph.
  - Ophtalmoscope and Ocular Pressure Measurement Device.
  - EEG, ECG Monitoring Devices.
  - Biochemical Laboratory with centrifuges.
  - Dedicated Medical Data Processing System.
- Medicine (in addition to above)
  - Equipment for testing of invasive treatment (animal testing).
  - Medical care equipment for non-invasive treatment (e.g. initially an improved Shuttle Medical Kit).
  - Hyperbaric chamber.

The diagnostic equipment needed for medical care and crew health check-up is the same one as the equipment for the human physiology research programme.

A major part of the equipment for the Human Physiology research programme will be available as space tested hardware by 1990 through programmes like the ESA Anthrorack and space SLED.
The medical care equipment will continuously be improved and extended as a result of the experiments and tests performed on the Space Station until ultimately a medical care clinic will be built up.

4.4 Space Station Relevance

The primary mission criteria for human physiology research and medicine on a Space Station is the presence of man with a very high crew involvement in the different research activities (Table 4.1).
Secondary mission criteria are:

- mission duration: weeks up to a year, and
- microgravity : $<10^{-3}$ g for some experiments.

An early start of the human physiology research in all subdisciplines is of greatest importance. Only so can the full utilization of the Space Station for the latter part of the 1990's be achieved, once the human adaptation and its limits in the space environment are fully known.

The development of adequate health care and medical treatment facilities will become an essential part of the research activities on a Space Station.

Table 4.1: MISSION CRITERIA FOR HUMAN PHYSIOLOGY AND MEDICINE

RESEARCH OBJECTIVE \ MISSION CRITERIA	COSMIC RADIATION	MICRO GRAVITY	VACUUM	CONTROLLED ATMOSPHERE	MISSION DURATION	CREW INVOLVEMENT	INCLINATION & ORBIT	TEST SUBJECTS				TEST PLATFORM		REMARKS
								MICRO-ORGANISMS	PLANTS	ANIMALS	CREW	SPACE STATION	UNMANNED FREE FLYER	
HUMAN PHYSIOLOGY	Con-trol-led	$<10^{-3}$ g	-	X	1week up to a year	very high	Stand. $+57^{0}$, 400km	-	-	X	X	X	-	Radiation level controlled to determination combined effects
MEDICINE	-	$\sim 10^{-2}$ g	-	X	weeks	very high	Standard	-	-	X	X	X	-	Gravity level controlled for medical experiments

The mission scenario for the Space Station contains Shuttle resupply missions every 60 - 90 days, later the interval might increase to up to 180 days. Between thesese revisits a return capability to ground is not available by other means than through a Shuttle emergency flight which could take 20-30 days to prepare for. An other costly alternative would be a dedicated emergency vehicle for Space Station to ground operations. It is therefore of outermost importance to develop medical diagnostic, therapeutic and treatment procedures and equipment in order to bridge the gap between Shuttle visits and to avoid expensive Shuttle emergency missions as far as possible.

4.5 Mission Implementation

The equipment needed for human physiology research and space medicine are very closely interrelated. A major part of the monitoring and measuring apparatus for the human physiology (e.g. ultrasound measuring devices, EEG, ECG, blood pressure, biochemical laboratory) is also direct applicable as diagnostic instruments for medical treatment. This will allow for a routine use of this equipment in physiology research, and at the same time the equipment is available in case of required medical care. To a large extent this equipment will be tested and used in human physiology research missions with Spacelab during the 1980's (e.g. ESA Anthrorack) (Table 4.2).

One problem to be solved before extensive medical care can be performed on a Space Station is the potential use of invasive methods in microgravity.

Table 4.2: HUMAN PHYSIOLOGY AND MEDICINE TIME PHASING

FUNCTIONS

HUMAN PHYSIOLOGY

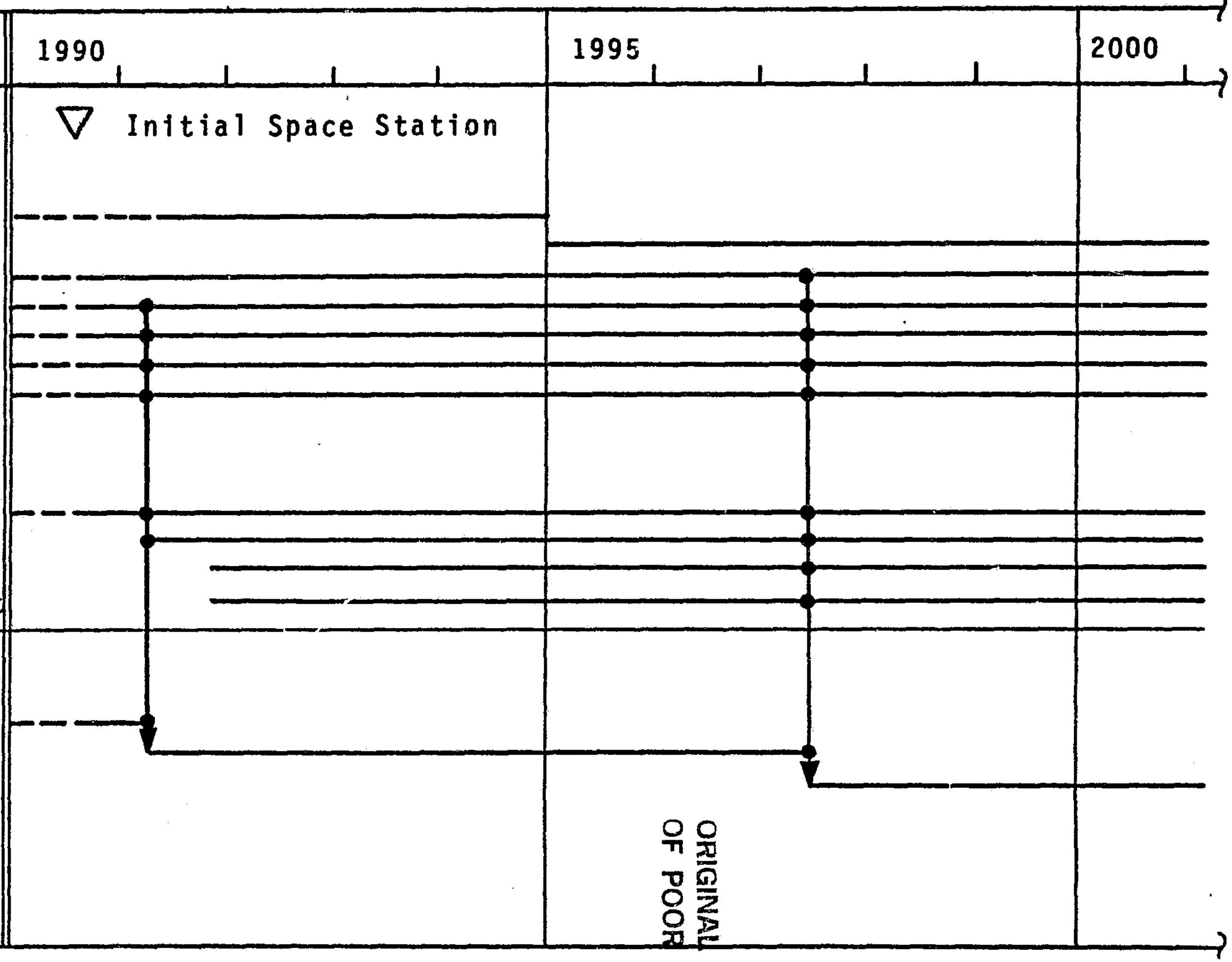
- SLED, Long SLED
- Human Centrifuge
- Exercise Equipment
- Respiratory Monitoring System
- Ultrasound Measuring Devices
- EEG, ECG, Blood Pressure etc.
- Biochemical Laboratory

MEDICINE

- Diagnostics
- Therapeutics
- Hyperbaric Chamber
- Invasive Methods Research/Treatment

MEDICAL FACILTIY

- Shuttle Medical Kit
- Medical Rack, Exercise Facility
- Dedicated Medical Clinic and Health Care Module



The expected increased number of crewmembers towards the end of the 1990's will require a dedicated Medical Clinic and Health Care Module. This module could also handle most of the continued human physiology research activities.

For the Initial Space Station, at first during the build up with more frequent Shuttle visits, an improved Shuttle Medical Kit in combination with the diagnostic equipment form the human physiology research programme will be available for medical care. Later on a dedicated Medical Rack with additional therapeutic equipment will be implemented. This will enable a detailed diagnosis to be performed by a crew member with elementary medical training (type paramedics) in direct contact with medical experts on ground before treatment and possible return to ground is initiated. A detailed diagnosis in space should provided the decision criteria for the necessity of a Shuttle emergency mission.

The Medical Rack facility will during the growth of the Space Station and with improved and new therapeutic methods (e.g. some invasive treatment) then expand into the Medical Clinic and Health Care Module as described above. The implementation of such a module would require an astronaut with an adequate medical training.

The implementation of a human centrifuge (diameter 15 - 20 m) is an explicit ambition of the scientific community in order to determine the influence of frequent shifts between microgravity and the 1 g condition. This would enable the final decision as to if artificial gravity for every long missions will be become necessary.

If such a centrifuge can be implemented on a Space Station in the 1990's requires further investigations. Envisaged problems are disturbances in the microgravity environment, and adequate space. The centrifuge is presently proposed as a one man cabin on a rotating arm outside the pressurized modules.

The typical Space Station requirements for Human Physiology and Medicine are based on data from hardware already existing or under development together with estimates from the scientific users community for hardware to be developed specifically for the Space Station (Table 4.3).

Table 4.3 : TYPICAL SPACE STATION REQUIREMENTS FOR HUMAN PHYSIOLOGY AND MEDICIN

RESEARCH OBJECTIVE \ SPACE STATION REQUIREMENTS	MISSION DURATION	MICRO-GRAVITY	MASS	VOLUME	POWER	CREW TIME	REMARKS
	DAYS	g	kg	m^3	kW	hrs/d	
HUMAN PHYSIOLOGY	8-60		25-100	0.1-0.5	0.1-1	0.5	CONTROLLED RADIATION LEVEL
						1-2	
	60-180	$<10^{-3}$	100-300	1-2	0.5-2	0.5	
						1-2	
	180-365					3-4	
			300-600	2-3	1-3	1-2	DOUBLE RACK LABORATORY
						3-4	
	30-90	$<10^{-3}$	500	30-40	2	2	LONG SLED
	90-365	$<10^{-3}$	1000 +	500 +	TBD	8-16	HUMAN CENTRIFUGE
MEDICINE	8-60	10^{-2}	25-100	0.1-0.5	0.1-1	1-2	CONTROLLED GRAVITY LEVEL FOR MEDICAL EX-PERIMENTS
			300-600	2-3	1-3	1-2	
MEDICAL FACILITY							
- MEDICAL RACK	90-	-	500-600	2	2-3	as req.	USED AS REQUIRED FOR MEDICAL CARE AND HEALTH CHECK-UPS IN ADDITION TO HUMAN PHYSIOLOGY RESEARCH
- MEDICAL CLINIC MODULE	90-	-	8.000-10.000	60-70	5-7	as req.	

5. LIFE SUPPORT SYSTEMS DEVELOPMENT IN THE 1990's

5.1 Objectives

As man extends his time in extraterrestrial activity, a new era of space exploration, utilization, and research is developing. It is expected that orbital activities such as satellite servicing and research will become routine. Potential uses for manned space stations include facilities for space astronomy, materials processing, biology research and earth resources research. In these, and other future space station activities, man with his unique mobility, work dexterity and adaptive decision-making capabilities will play an essential role. It is recognized, however, that for extended duration missions in space the practical supply of basic life-supporting ingredients represents a formidable logistics problem. Storage volume and weight of water, oxygen and food in a conventional non-regenerable life support system are directly proportional to the crew size and the length of the space mission. In view of spacecraft payload limitations, the inescapable conclusion is that extended-duration manned space missions will be practical only if advanced life support systems can be developed in which metabolic waste products are regenerated into consumable life support factors by Biological Life Support Systems (BLSS) or Closed Ecological Life Support Systems (CELSS).

BLSS functional requirements for space application will be to supply oxygen, water and food in support of human life, on a continuous basis, while maintaining a balanced stable spacecraft ecology. While the precise components of the BLSS will be mission-dependent, it seems apparent that the BLSS will be biotechnical in composition consisting of human, animal, plant and microorganisms integrated with other physio-chemical elements.

Some factors of human/plant/microorganism co-habitability are understood, but, additional research to provide basic knowledge in a number of technologies remains necessary.

The biological systems have a very high complexity and an extensive space testing on subsystem and system level will be necessary. The Space Station will therefore first be used as a test platform for long duration experiments, before the biological life support systems will be implemented step-wise by replacing the physico-chemical subsystems.

5.2 Mission Drivers

Due to its complexity the development of a future biological life support system for Space Stations requires a twofold approach.
The selection of species (animals and plants) the intensification of cultures and the improvement of waste treatment by experimental investigations have to be supported by mathematical models to decrease development risks. The experimental development program starts out with the specification of the human diet and the vitamin and trace minerals requirements. Compatible with these human requirements and the environmental conditons of a space station, the next step should select the animal and plant species required. This selection will be reevaluated and retested as the development of a BLSS makes progress in the following areas:

- intensification of cultures,
- waste treatment, and
- control mechanisms.

Many single experimental investigations in various disciplines will be necessary for the evaluation of the biological, chemical and technical basis for these areas before they can be integrated into subsystems whose functional coupling and reliability under these conditions can be tested. The theoretical approach, going hand in hand with the experimental one, will utilize mathematical models.
Assessing the required ECLS functions (oxygen supply, CO_2-removal, food production and water reclamation) for a BLSS indicates that the food production requirements is the design driver for higher plants. A system sized for food production will be in the position to handle the other ECLS functions without an increase in size.

5.3 Equipment

A survey of the literature on BLSS/CELSS and associated subjects, as well as the results of the study performed by Dornier System and Hamilton Standard, reveal a list of general scientific and technology development open issues.

Based on this list, a preliminary selection of initial technical development tasks for the experimental study of BLSS has been performed:

a) Impact on micro-gravity on biological material during cultivation.

b) Impact of micro-gravity on culture methods.

c) Impact of solar radiation with high intensities in the PAR-region on photosynthetic activity of biological material.

d) Impact of cosmic radiation on biological material.

e) Optimization of biological material.

f) Optimization of cultivation methods.

g) Optimization of harvesting methods.

h) Recycling of energy.

i) Recycling of wastes.

j) Monitoring and control.

k) Improvement of mathematical modelling of complex systems.

l) Selection of diet for the crew.

This listing of technical development tasks serves as a basis for the definition of required equipment for Space Station testing and implementation of BLSS. In addition to the basic life sciences research equipment for gravitational and radiation biology (para 3.3) equipment for cultivation, harvesting, waste recycling, and monitoring and control will be needed. Later on larger greenhouse facilities will become an essential part of the Space Station and the life support system.

5.4 Space Station Relevance

The problems defined above have to be subdivided into those which absolutely require conducting of studies in space and those which can be studied and solved in terrestrial research programmes. Furthermore, priorities should be set as to whether the problem is relevant in the very near future (short-term relevance, pre-pilottype) or not (far-term relevance, pilottype).

Generally speaking, only those problems need to be studied in space, which:

- require a micro-gravity environment, and/or
- are cosmic radiation dependent.

The BLSS studies, to date, have indicated two blocks (pre-pilot and pilot type) of experiments and analysis which are required for the support and promotion of the development of BLSS (Table 5.1).

Pre-pilottype studies should center around the problem of providing the crew with a certain amount of fresh greens. The culture methods are characterized by the use of prepared beds or pots which contain a medium either in the form of solid fertile soil (agar-plate) or sponge-like substances.

The interface of the ECLSS with the spacecraft and with outer space (sunlight) should be as simple as possible.

(x)=need for exp. still to be defined

TASK	Pre-Pilot Type		Pilot Type	
	Terrestrial	Space	Terrestrial	Space
O-g influence during cultivation	x	x		x
O-g influence on culture-methods	x	x		x
Solar radiation in PAR region impact on biological material	x		x	x
Cosmic radiation	X	X		
Optimization of biological material	X	(X)	X	
Optimization of cultivation methods	X	(X)	X	
Optimization of harvesting methods	(X)	(X)	X	X
Energy recycling	X		X	
Waste recycling	X		X	
Monitoring and Control	X	X	X	X
Improvement of mathematical modelling	X		X	
Selection of diet	X		X	
Development of large area windows for PAR and IR	X	X		
Refined theoretical model	X		X	

Table 5.1: Problems to be Studied in the BLSS Development

C-4

Pilottype studies focus on the design and testing of a reference system which simulates the ECLSS with its biological subsystems intended for flight application. Reference systems will then be designed and tested along with the development of physico-chemical subsystems.
Whereas in pre-pilot studies principle aspects of BLSS are experimentally investigated, the aims of pilot type design and testing of a reference system is the closure of the water, atmosphere and carbon loops.

The development of a specific flight experiment should follow the generalized flow diagram (Fig. 5.1). This flow diagram takes into account the known typical BLSS design parameters. This philosophy can be used for the definition of new BLSS flight experiments as well as for the evaluation of modifications to planned experiments.
The mission criteria for the various research and development tasks have been listed in Table 5.2.

5.5 Mission Implementation

It is anticipated that basic BLSS-dedicated research and testing will be initiated as Spacelab or EURECA experiments in the 1980's. These together with results of various life sciences experiments on plant biology will form the basis for continued pre-pilot experiments on the Space Station to solve BLSS-questions of basic nature.

Soon thereafter smaller reference systems will be implemented on the Space Station for testing in parallel with the basic regenerative physico-chemical life support system.

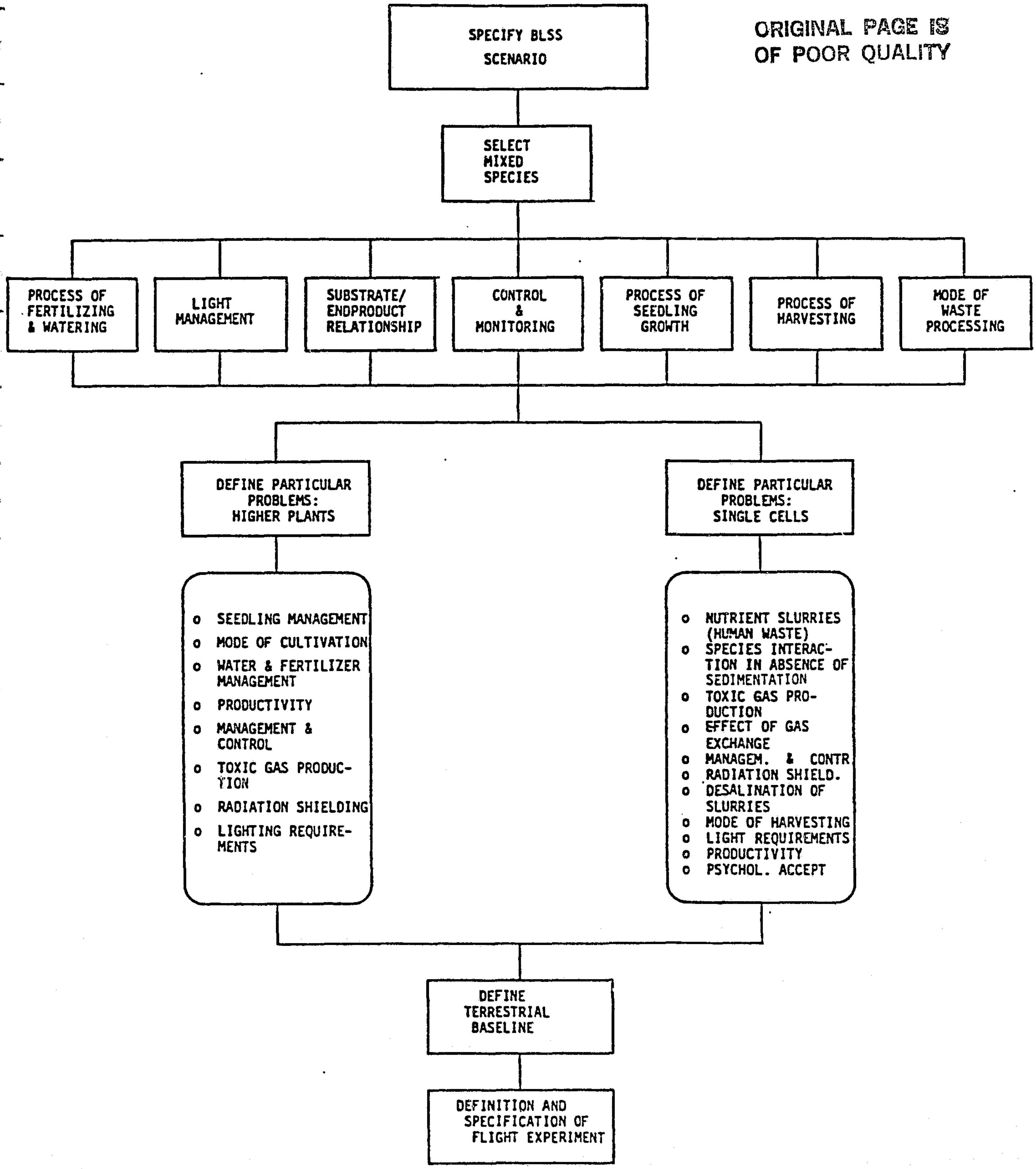


Fig. 5.1: Development of Flight Experiments for BLSS

Table 5.2: MISSION CRITERIA CLOSED LIFE SUPPORT SYSTEMS

RESEARCH OBJECTIVE \ MISSION CRITERIA	COSMIC RADIATION	MICRO GRAVITY	VACUUM	CONTROLLED ATMOSPHERE	MISSION DURATION	CREW INVOLVEMENT	INCLINATION & ORBIT	TEST SUBJECTS: MICRO-ORGANISMS	TEST SUBJECTS: PLANTS	TEST SUBJECTS: ANIMALS	TEST SUBJECTS: CREW	TEST PLATFORM: SPACE STATION	TEST PLATFORM: UNMANNED FREE FLYER	REMARKS
CULTIVATION METHODS	-	X	-	X	Weeks up to a year and more	High	Standard	-	X	(X)	-	X	-	At the end of 1990's animals might be included in ecological life support systems
HARVESTING METHODS	-	X	-	X		High	Standard	-	X	(X)	-	X	-	
COSMIC RADIATION	X	(X)	-	X		Low	57^0, 400 km	-	X	-	-	X	X	Preliminary exp. on unmanned platform, combined effects
LIGHT MANAGEMENT	X	X	-	X		Medium	Stand.	-	X	(X)	-	X	-	PAR region. without cosmic radiation
WASTE RECYCLING	-	X	-	X		Medium	Stand.	-	X	(X)	-	X	-	
MONITORING AND CONTROL	-	X	X	X		Medium	Stand.	-	X	(X)	-	X	-	

These reference systems will become the Character of small greenhouses, which will provide the crew with a certain diet variety of fresh vegetables (Table 5.3).

Towards the end of the century the development of BLSS/CELSS has advanced that far that more and more of the basic environmental control and life support functions can be taken over by the ecological system in form of e.g. a dedicated Ecological Life Support Modules.
Typical Space Station requirements for ecological life support experiments and systems are very difficult to estimate at this early stage. Based on results of Dornier System - Hamilton Standard feasibility studies some preliminary figures have been estimated as a guideline for further analysis (Table 5.4).

The figures for the Ecological Life Support Module are based on a phototrophic efficiency of about 2,5%. If the efficiency could be increased, weight and volume could be reduced considerably, but the required power would increase very rapidly.

Table 5.3: CLOSED LIFE SUPPORT SYSTEMS TIME PHASING

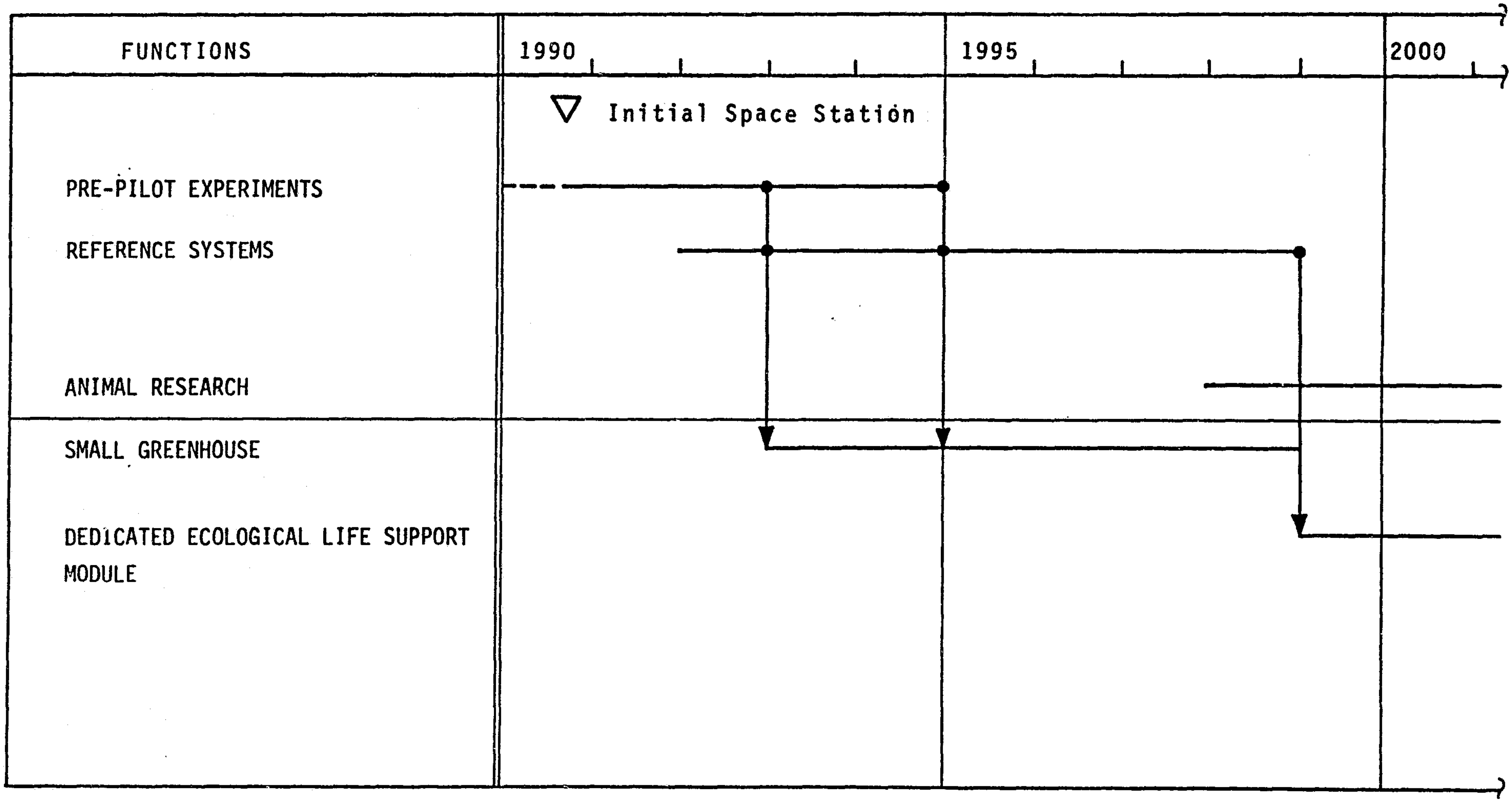


Table 5.4 : TYPICAL SPACE STATION REQUIREMENTS FOR CLOSED LIFE SUPPORT SYSTEMS

RESEARCH OBJECTIVE / SPACE STATION REQUIREMENTS	MISSION DURATION	MICRO-GRAVITY	MASS	VOLUME	POWER	CREW TIME	REMARKS
	DAYS	g	kg	m^3	kW	hrs/d	
ECOLOGICAL LIFE SUPPORT SYSTEMS							
- PRE-PILOT EXPERIMENTS	30-90	10^{-2}	25-100	0.1-0.5	0.5-1	1-2	
		to	100-300	1-2	1-2	1-2	
	90-180	10^{-3}					
	1-2 years						
- SMALL GREENHOUSE	1-5 years	10^{-2}	500-1.000	20-50	3-5	1-2	WOULD PROVIDE EDIBLE GREEN PLANTS FOR A CREW OF 4.
- ECOLOGICAL LIFE SUPPORT MODULE	years	10^{-2}	10.000-12.000	200-300	12-15	3-4	FOR A 4 MAN CREW TO PROVIDE FOOD, WATER AND OXYGEN.

6. CONCLUSIONS

Mission scenarios for the various subdisciplines of life sciences and life support development for Space Station applications have been defined to a level of detail, which will enable the analysis of various architectural options for a Space Station.

The life sciences community has well defined objectives for their activities in the 1990's and in particular the potential use of the Space Station. These objectives provided the basis for the analysis of mission criteria, the experiment time phasing and the determination of typical Space Station requirements for the various life sciences subdisciplines.

The life sciences programme was split into:

- Life Sciences Research (basic; Gravitational Biology, Radiation Biology and Exobiology)
- Human Physiology and Medicine, and
- Life Support Systems.

This enabled a clear requirements definition and a logical build-up of the activities on a Space Station. Furthermore the distinct character of a Space Station subsystem for the Operational Medicine and the Life Support Systems is pronounced by the foreseeable dedicated Medical Clinic and Health Care Module, and the Ecological Life Support Module towards the end of the 1990's.

For each of the subdisciplines the life sciences community provided detailed equipment lists which supported the elaboration of Space Station requirements for a set of typical payloads.

The strong interest of the Life Sciences Community in the use of a Space Station was documented in a pertinent participation in a German workshop for potential users of a Space Station held during the course of this study. This workshop provided valuable data on the use of a Space Station for life sciences research and life support system development.

7. REFERENCES

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TD (83) 1, January 1983.

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SPACE STATION PROGRAMS

ATTACHMENT 2

SUPPORTING DATA AND ANALYSIS REPORTS

VOLUME I

SPAR REPORT

Lockheed

SPAR

Space & Electronics Group
1700 Ormont Drive, Weston, Ontario, Canada M9L 2W7

January 13, 1983

Dr. Kevin Forsberg
Space Station Program Manager
Lockheed Missiles and Space Company Inc.
1111 Lockheed Way
P.O. Box 504
SUNNYVALE, CA 94086
U.S.A.

Dear Kevin:

Subject: Spar Support to LMSC Space Station Study

Enclosed with this letter is a copy of the final report prepared by Mr. Brian Thomas, summarizing his activities at LMSC in December.

In reviewing the report, it appears that a great deal of useful work was undertaken and that a valuable exchange of technical information took place to the mutual benefit of LMSC and Spar.

We are preparing cost data for various remote handling equipment for the Space Station and will pass this data on to you over the next few weeks. Also, we look forward to providing a critique of your final report when available. Upon completion of these two activities, we believe the intent of our SOW will have been achieved.

We note your comments concerning future cooperation on Space Station and would welcome an opportunity to discuss this further at an appropriate time. Our current study for the National Research Council of Canada will be completed in June this year and shortly thereafter we would hope to have some indication of the extent of any potential Canadian

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contribution and the modus operandi. In the meantime we should continue the technical and programmatic liaison that has been initiated and discuss potential scenarios for working together in the future. Perhaps we can get together sometime in the next few weeks?

Brian Thomas has asked me to pass on his appreciation for the cooperation and cordiality extended to him during his visit.

Yours very truly,

Brian R. Fuller
Business Development Department
Remote Manipulator Systems Division

:pc

VISIT REPORT

Distribution:

B.R. Fuller
J.A. Middleton
R. Neville
P.A. McIntyre
P.N. Ibbotson
Dr. K. Forsberg

VISIT REPORT

To: Distribution

Date: 22 Dec. 1982

From: B. Thomas

Subject: Visit to LMSC Sunnyvale, Ca. on the Space Station

Date of visit December 6 to December 17, 1982.

LMSC Personnel contacted:

Kevin Forsberg	Program Manager
Don Smith	Deputy Program Manager
Tom Fisher	
Joe Morgan	
Paul Bene	
Derek Gardner	
Ed Waller	
Bill James	
Mike Wilson	

Activity:

The initial discussions were with D. Smith and T. Fisher. Tom presented the list of candidate tasks, Appendix B, as a starting point for discussions. My comments against these tasks are included in Appendix B.

The next step was to consider possible applications of the SRMS on the Space Station. The LMSC list of possible interfaces and my comments are in Appendix C.

Very little work had been done by LMSC on architectural concepts, most work has been done on generation of 'scenarios'. 17 scenarios have been generated, two of these were not available to me, the other 15 are included as Appendix F.

Towards the end of the two weeks some discussions were held on possible space station configurations. LMSC would like to generate a distinct LMSC space station that will be readily recognisable. Most of the "architecture" work done so far had been in association with another space program that used the SOC space station. Consequently the starting point for the space station was SOC. The LMSC work and my sketches are included in Appendix E.

Exchange of data was relatively limited. I left with LMSC a number of Spar papers; a list of relevant reports and ICDs; copies of 3 ICDs. LMSC gave me in addition to the material in Appendices B,C, E & E, the program and LMSC organization charts. The lists and any charts are in Appendix G.

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My approach had been to see if the activities associated with the LMSC identified interfaces, payloads and scenarios could be accomplished using SRMS and derivatives there-of. The conclusion I reached as seen in my final presentation to LMSC, Appendix A, is that the tracked SRMS and other developments from Spar designs can do all the Space Station work so far identified.

The final wrap up presentation was given to Dr. K. Forsberg, T. Fisher, W. James and E. Waller. The material presented was:-

- Discussion of Appendix B.
- Discussion of Appendix C
- Figures in Appendix D were used to make points in above discussions
- Discussion of possible architecture Appendix E
- Final wrap-up Appendix A

Space Station Recommendations:-

- SPAR - LMSC liaison continue through current phase and Phase A
    - o Spar complete activity started in last two weeks:
        - Supply final report on visit
        - Outstanding cost and other data as appropriate
        - Review aspects of final report relevant to Spar
- Spar to clarify when practical the Spar/Canadian position on Space Station particularly with respect to
    - o Extent of Spar-LMSC co-operation
    - o Equipment chosen by Spar for future development
- Spar to provide data sheets on candidate equipment concepts
- LMSC to explore avenues for contractural co-operation with Spar
- Development to proceed in the next year on
    - o Turn/Tilt table
    - o Track mounted RMS
    - o Special tools and end effectors

The comments made by Dr. Forsberg at the end of my presentation were to the effect that the work done to date was just what was needed at this time and that co-operation between the space station group and Spar should continue. Other areas of co-operation on the Space Station should also be explored, beyond SRMS.

B Thomas

B. Thomas

APPENDIX A

PRESENTATION MATERIAL - FINAL WRAP-UP MEETING

- SPACE STATION - REQUIREMENTS FOR RMS -

SPAR

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- ASSEMBLY OF BASIC STRUCTURE
  - SRMS
  - SHUTTLE MOUNTED SPAR HPA
  - SPECIAL END EFFECTORS
  - SPECIAL TOOLS
- SPACE STATION R&D
  - TRACK MOUNTED RMS
  - RMS CONTROL STATION
  - TURN TILT TABLE
- "MID" SPACE STATION
  - ADDITIONAL TURN/TILT TABLES
  - LONG REACH RMS
- ADVANCED SPACE STATION
  - EXTENDED TRACK FOR RMS
  - TETHERED FLYING RMS
  - FREE FLYING RMS (TMS)

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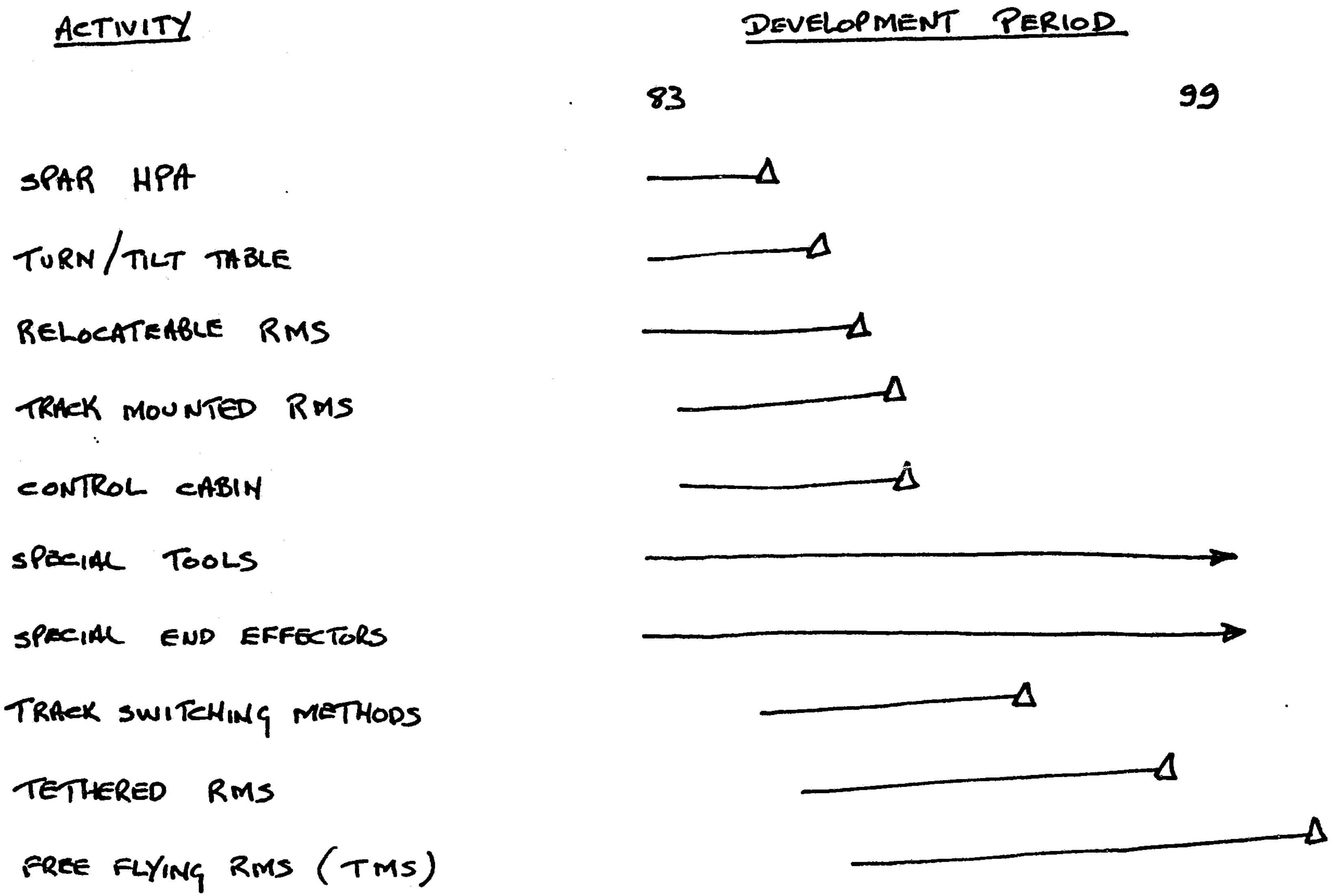
- SPACE STATION - POTENTIAL RMS DEVELOPMENT -

SPAR



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RMS - CURRENT

- PER SHUTTLE OPERATIONS - COULD HAVE ADDITIONAL TRAVEL IN SOME JOINTS

- ADVANCED

- HPA - SHORT ROBUST VERSION OF SRMS - TYPICALLY 15FT REACH
- AFT MOUNTED SRMS
- EXTENDED REACH - 100FT REACH OR GREATER.
- ADDITIONAL DEXTERITY - ADDED DEGREES OF FREEDOM.
- TURN/TILT TABLE - DERIVED FROM SRMS SHOULDER JOINT.

- TRACKED

- BASIC SRMS OR HPA MOUNTED ON A CARRIAGE, INITIAL DEVICE TO TRAVEL ON A STRAIGHT TRACK, LATER DEVELOPMENTS TO TRAVEL ON CURVED TRACKS OR TO SWITCH TRACKS

- CONTROL STATION

- SPACE STATION MOUNTED "COCKPIT" FOR CONTROL OF TRACKED RMS, TURN/TILT TABLES ETC. CONTROL STATION COULD BE RELOCATEABLE.

16. DEC. 82

SPAR

TELEOPERATOR STATION - TETHERED OR FREE FLYING STATION INCLUDING RMS CAPABILITY. DEVELOPED FROM ELEMENTS/CONCEPTS ABOVE.

OTHER - END EFFECTORS AND GRAPPLE FIXTURES.

- TO BE DEVELOPED FROM EXISTING HARDWARE, WHICH INCLUDE: STANDARD E.E., ELECTRICAL E.E., SWITCHING G.F.,

- TOOLS

- FOR USE WITH END EFFECTORS OR AS SPECIAL PURPOSE END EFFECTORS, EXAMPLES ; ROD HOLDING ; PLATE HOLDING; MODULE REPLACEMENT - UNIVERSAL SERVICE TOOL SYSTEM.

- EVA SUPPORT AND ASSOCIATED EQUIPMENT

- CHERRY PICKER, OPEN OR CLOSED CONCEPT
- STABILIZER ARM
- PROXIMITY SENSING
- FORCE FEEDBACK.

16 · DEC . 82

SPAR

- SPAR - LMSC LIAISON CONTINUE THROUGH CURRENT PHASE AND PHASE A'
  - SPAR COMPLETE ACTIVITY STARTED IN LAST TWO WEEKS:-
    - SUPPLY FINAL REPORT ON VISIT
    - OUTSTANDING COST AND OTHER DATA AS APPROPRIATE.
    - REVIEW ASPECTS OF FINAL REPORT RELEVANT TO SPAR.
- SPAR TO CLARIFY WHEN PRACTICAL THE SPAR/CANADIAN POSITION ON SPACE STATION PARTICULARLY WITH RESPECT TO
  - EXTENT OF SPAR-LMSC COOPERATION
  - EQUIPMENT CHOSEN BY SPAR FOR FUTURE DEVELOPMENT
- SPAR TO PROVIDE DATA SHEETS ON CANDIDATE EQUIPMENT CONCEPTS.
- LMSC TO EXPLORE AVENUES FOR CONTRACTURAL COOPERATION WITH SPAR.
- DEVELOPMENT TO PROCEED IN THE NEXT YEAR ON
  - TURN/TILT TABLE
  - TRACK MOUNTED RMS
  - SPECIAL TOOLS AND END EFFECTORS

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APPENDIX B

CANADIDATE TASKS - T. FISHER LIST OF TASKS
- B. THOMAS COMMENTS

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CANDIDATE TASKS

FIXED BASE	'MANEUVERABLE' RMS
A. IMPACT OF AFT MTD. RMS	1. CLOSED CAB - FREE FLYER (MANNED)
B. FEASIBILITY FOR GROWTH VERSION OF RMS	2. OPEN CAB - FREE FLYER (MANNED)
C. END EFFECTOR CANDIDATES	3. REMOTE OPERATED RMS • CONSTRUCTION/ASSY. • SERVICING • GENERAL PURPOSE
D. TRACKED CRANE RMS APPROACH	
E. RMS SEGMENT OPTIONS	4. REMOTE OPS CONCEPT
F. ADDED ARTICULATION	5. 'UNIQUE MANEUVERABLE' RMS CONCEPTS
G. TWO RMS OPS SIMULTANEOUSLY	
H. RMS REQTS FOR CONSTRUCTION/ASSY.	
I. STANDARD RMS TIMELINE SEGMENTS	
J. UNIQUE 'RMS' CONCEPTS	
K. RMS VS BERTHING DEVICES	

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Prepared: T. FISHER

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15 December 1982

Review of T. Fisher Candidate Tasks

1.0 Fixed Base

A. Impact of Aft Mounted RMS

The aft mounting of the SRMS has been shown by SPAR to be feasible and can be used for project planning purposes. A number of areas need to be resolved before the aft mounted SRMS becomes a fact of life, these include: longeron stiffness; retention loads; reverse direction launch vibrations.

B. Feasibility For Growth Version of RMS

SPAR is considering growth versions of the SRMS up to 100 ft overall length, load capability, joint and boom sizes will be established when the potential uses are better defined.

C. End Effector Candidates (EE)

The current EE and grapple fixture designs are based on the "wire iris" concept with variations including - electrical
- switching

Various tools can be used in association with the EE. The tools so far considered include - universal service tool system
- rod holder
- plate holder

D. Tracked Crane RMS Approach

The "tracked crane RMS" is considered by SPAR to be a highly likely development for the space station. Very little project development work has been down so far.

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Problem areas to be resolved include:

- Power pick-up configuration
- Track sizes — length of track
  — track spread
- Wheel tie down

E. RMS Segment Options

Changes to the basic SRMS to add or delete joints or shorten boom lengths have been considered, major effects will be on time lines and loads capabilities, which will require major software revisions. Major arm boom extensions is covered under task B.

F. Added Articulation

The addition of joints to achieve a particular scenario is within the current baseline for space station.

G. Two RMS Operating Simultaneously

The SRMS is designed to use two SRMS on a single job. The method of operation is such that only one SRMS is being operated at any one time. To operate the other SRMS it is necessary to physically switch control of the D&C panel.

H. RMS Requirements for Construction/Assembly

This area is covered separately.

I. Standard RMS Timeline Segments

Information will be supplied of standard timeline segments such as:

- set up and check out
- shut down, stow and turn-off

and any other standard segments that are available

J. Unique "RMS" Concepts

e.g. - HPA

- Turn tilt table

K. RMS Vs. Berthing Devices

Berthing of the shuttle using the SRMS is a viable proposition, as discussed in the RI final SOC report. This berthing method has been studied by SPAR for space station weight up to 250,000 lbs.

2.0 Maneuverable RMS

The use of any "separated" RMS concept needs extensive development. Some of the concepts identified appear to be more potentially achievable than others. The concepts are considered in turn below.

2.1 Closed Cab - Free Flyer (Manned)

This concept was considered previously by SPAR as the MRWS. The concept is achievable.

2.2 Open Cab - Free Flyer (Manned)

As 2.1 above.

2.3 Remote Operated RMS

This concept is considered separately.

2.4 Remote Operating Concept

More data required.

2.5 "Unique Maneuverable" RMS Concept

Unique concepts can be developed to respond to most particular requirements.

APPENDIX C

RMS INTERFACES - T. FISHER LIST OF CANDIDATES
- B. THOMAS COMMENTS

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RMS INTERFACES

CANDIDATE SYSTEM	SIZE (FT.) L	W	D	WEIGHT (LBS)	ACCESS
A. SPACECRAFT					
1. SPACE TELESCOPE/AXAF	43	14.5 DIA		24K	360°- FULL LENGTH
2. USAF SPACE VEHICLE	55	14.5 DIA		60K	" " "
3. MULTI-MODULAR S/C	12	10 DIA		12K	" " "
B. PALLET/RACK					
1. ESA PALLET	9.5	14.5	10	< 10K	FWD/AFT/TOP
2. USAF RACK	12	14.5	10	< 14K	" " "
C. STAGES					
1. MULTI STAGE IUS	35	13 DIA		81K	360° - FULL LENGTH
2. ORBIT TRANSFER VEHICLE (A)	85	14 DIA		138K	" " "
3. ORBIT TRANSFER VEHICLE (B)	52	14.5 DIA		63K	" " "
D. HABITABILITY MODULE	24/50	14.5 DIA		16 TO 52K	FWD/AFT
E. LOGISTICS MODULE	24/50	14.5 DIA		21 TO 55K	FWD/AFT
F. AIRLOCK/DOCKING MODULE	52	14.5 DIA		16 TO 35K	FWD/AFT
G. POWER MODULE	10/40	14.5 DIA		15/30K	360°- FULL LENGTH

Prepared: T. FISHER — 8 DEC 82
Checked
Approved

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09 December 1982

RMS INTERFACES - CANDIDATE SYSTEMS REVIEW

1st Consideration - Servicing of Candidate Systems

Candidate systems can be reorganized into the following sub-sets:

- o Circular - requiring access to full length

  e.g. A.1, 2, 3 and G

- o Circular - requiring sub-module assembly and possible access to full length

  e.g. C.1, 2 and 3

- o Circular - requiring access to ends

  e.g. D, E and F

- o Non-Circular - requiring access to ends and top

  e.g. B

Servicing of Circular Payloads (no payload assembly)

Assumptions:

1. Payloads will be handled so that end effector loads do not exceed SRMS baseline.
2. Special end effectors and/or tools or EVA may be involved in servicing. Special tools will be specified when more details of needs are known.
3. Payload to be mounted by one end so that it can be rotated about its own axis or tilted to provide suitable access for servicing or handling.
4. Turn and tilt device configuration is similar to a SRMS shoulder pitch and yaw joint assembly mounted with the pitch portion attached to the space station and the yaw (axial rotation) portion attached to the payload.

   NOTE: Maximum Kinetic energy of SRMS joints is 29-06 lb ft (for each joint) for mechanical stops; drive torque 772 ft lb; Brake slip torque 821 ft lb.

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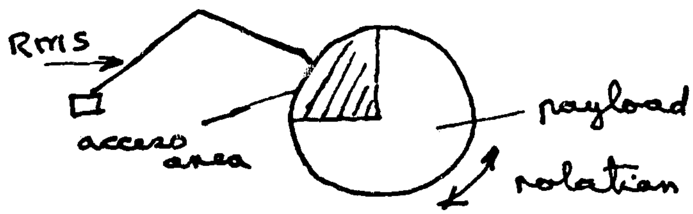
5. Access to the payload by the RMS will be to one quadrant of the payload. If access is required to other areas the payload will be rotated.



6. Servicing activity will basically require the end effector to move in a straight line 10 ft on a radial of the payload, adequate clearance must be provided to allow for this movement.
7. The movement identified in 6 will be achievable at least for payloads 60 ft long, using a single fixed position RMS. Using a RMS mounted on rails the 60 ft will be increased by the length of rails used.

Servicing of Circular Payloads with Some Assembly

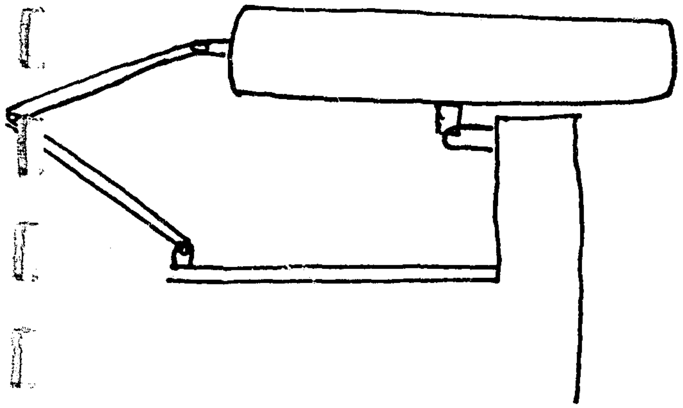
Assumptions:

1. Servicing activity will be the same as for basic circular payloads.
2. The longer payloads will be made up from 2 or 3 smaller assemblies. Handling of these shuttle delivered payloads will be by SRMS to pre-determined points on the space station.
3. By using the two hangers and the central tilt/turn table the RMS will be able to perform all handling and assembly placement tasks.

Servicing of Circular Payloads Requiring Access to Ends

Assumptions:

1. Payload can be berthed at mid point and rotated to allow the tracked RMS to service either end in turn.

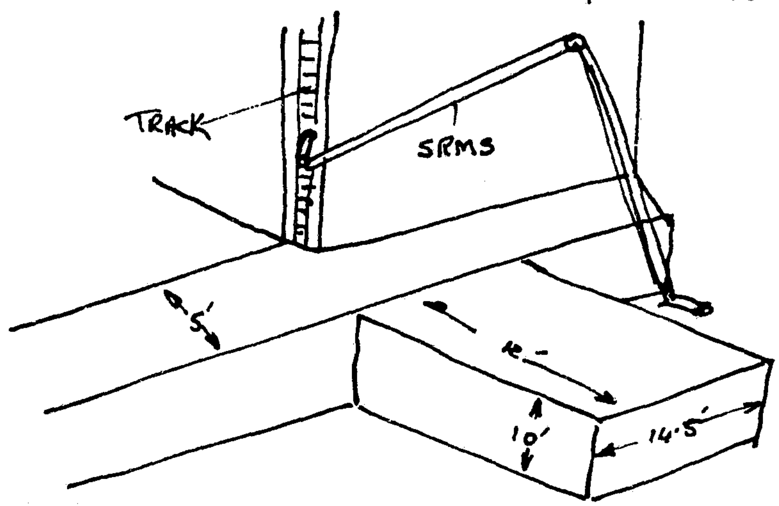


ACCESS TO END OF LONG PAYLOAD.

Servicing of Non-Circular Pallets and Racks

e.g. B.2

Length: 12 ft Width: 14-5 ft Depth: 10 ft



RMS located at position shown will be able to service forward aft and top of pallet

10 December 1982

2nd Consideration - Berthing/Docking

Two levels of this consideration are:

a) Berthing of STS to space station.

b) Transfer of payloads from STS to space station

a) Berthing STS

Two basic scenarios:

i) Hard docking

ii) Free floating

i) Hard docking will be done using SRMS. The capability of SRMS to do this task is discussed on pages 52 and 53 of RI Final Review for NAS9-16153. (February 1982)

ii) Free floating of the STS adjacent to the S/S will not required mechanical handling devices at that time.

b) Transfer of Payloads

i) Transfer of a payload from a docked STS should be initiated by SRMS. The transfer could be to another RMS on the S/S or to a docking module at a known location and orientation. Assume that the transfer is from SRMS to S/SRMS. The S/SRMS will then position the payload on the turn/tilt table or a designated docking module.

ii) Transfer of a pyaload from a free floating STS would be initiated by by SRMS. SRMS would position the payload so that it could be "flown" by an astronaut to an appropriate location and orientation to be captured by S/SRMS. Alternately the STS could be positioned near

enough the space station to allow the payload to be handed off by the SRMS to the space station RMS as in b(i) above.

10 December 1982

3rd Consideration - Undocking-Relocating-General Handling

The handling devices, SRMS, etc. mentioned above will cover the handling requirements at specific locations. Not covered above is handling of large/heavy items, handling at interim locations, transporation or storage.

APPENDIX D

COPIES OF DIAGRAMS FROM SPAR PAPERS

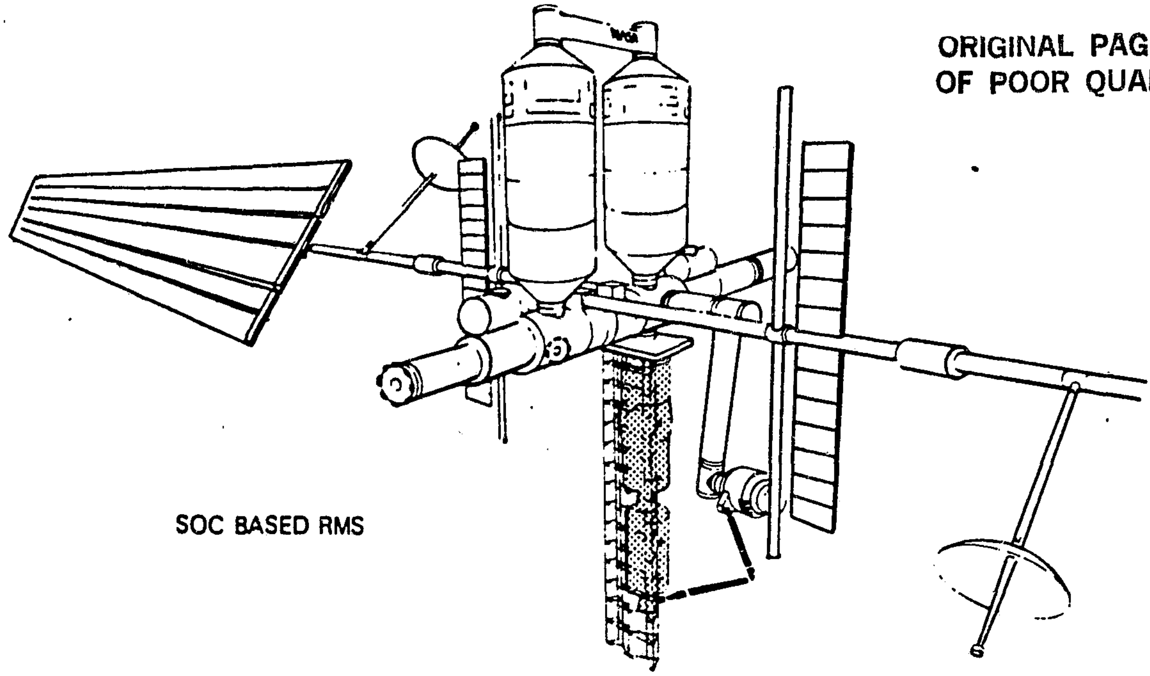


FIG.6 RMS CONCEPTS FOR SOC

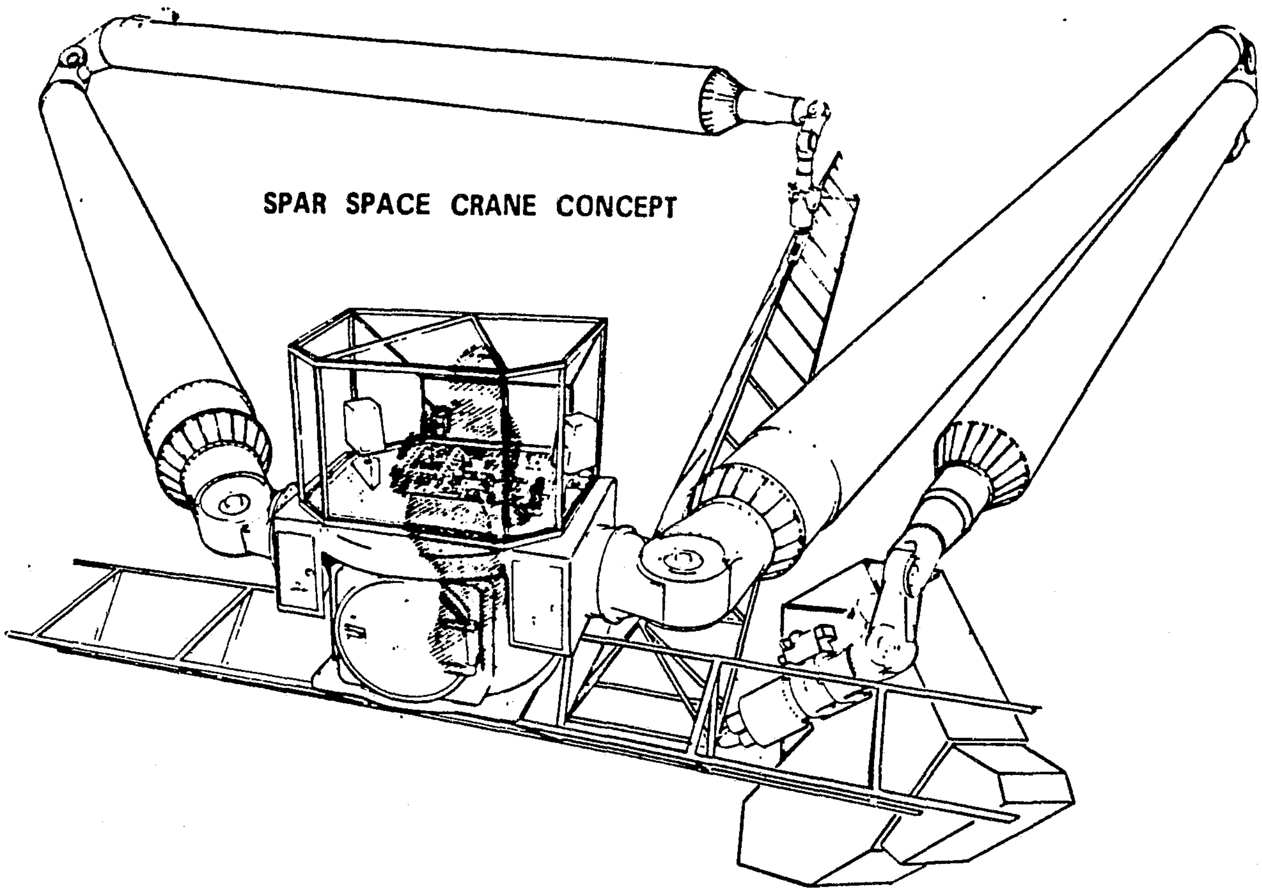


FIG. 7 SOC CONSTRUCTION CONCEPT

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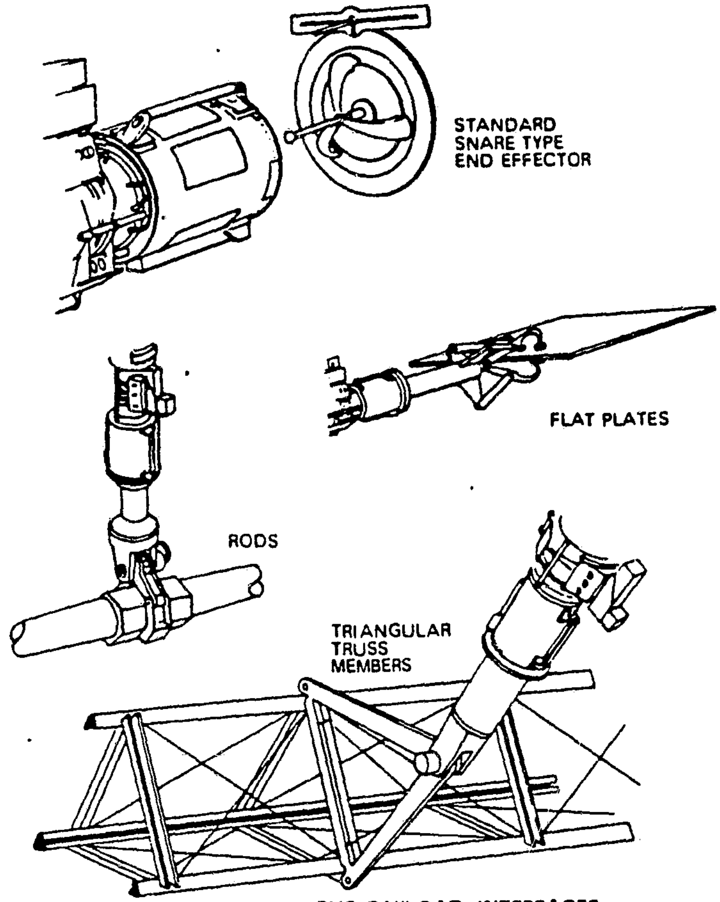


FIG. 4 RMS PAYLOAD INTERFACES

cargo bay. The RMS with the Universal Service Tool (see Figure 5) attached will remove the depleted module from the spacecraft and replace it with a new one taken from the cargo bay storage magazine. The depleted module is then secured in the magazine for earth return. When the work is completed, the satellite is redeployed into orbit.

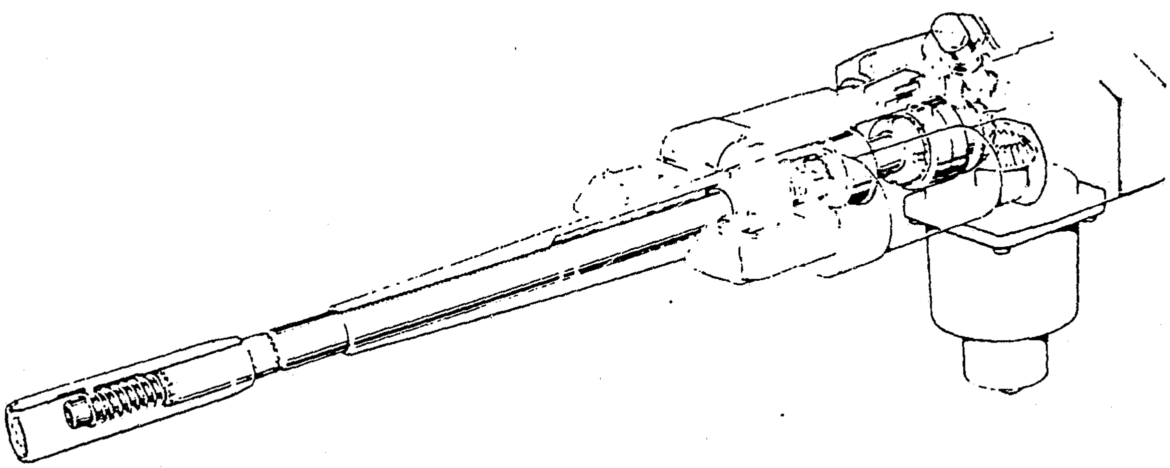
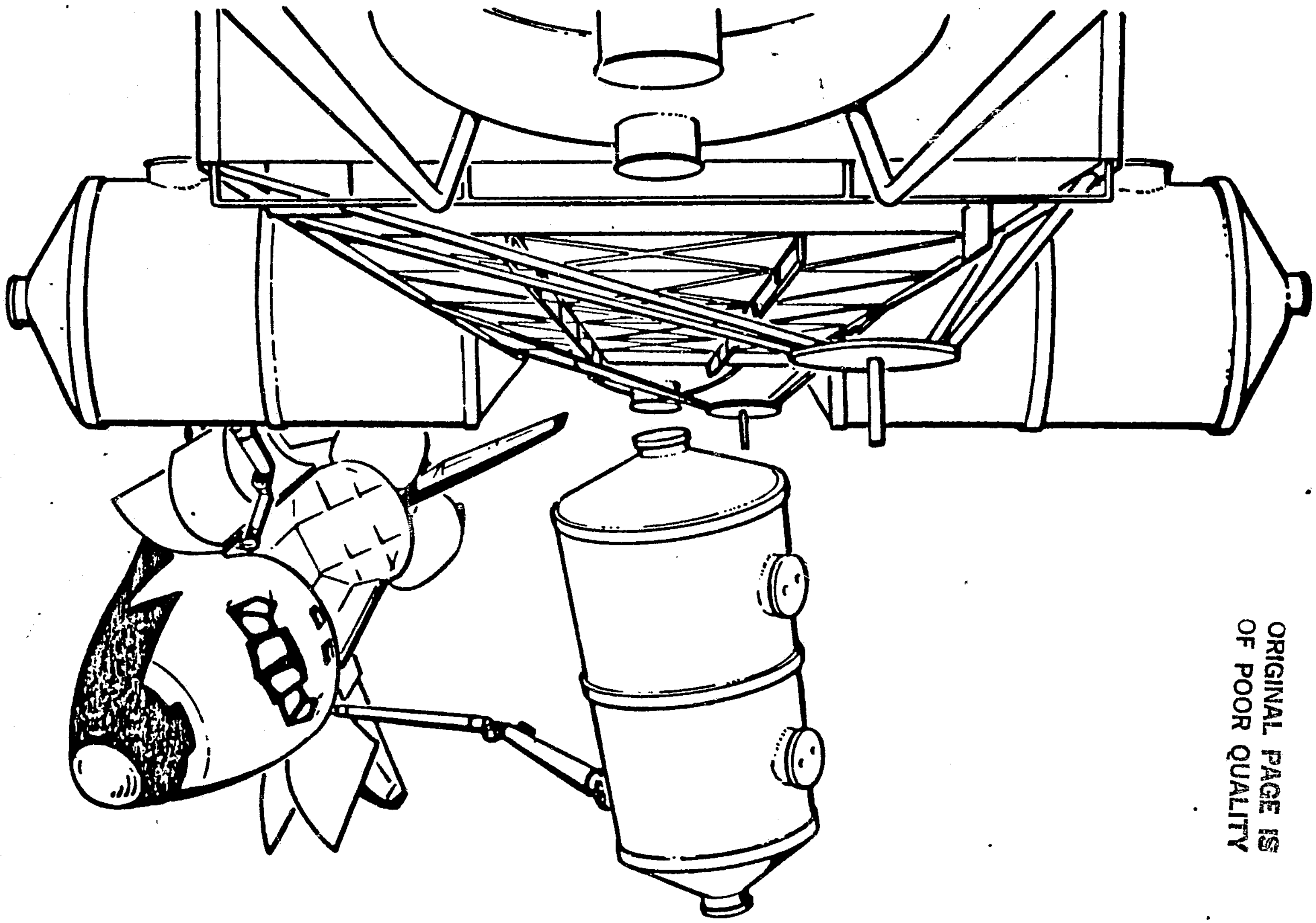


FIG. 5 UNIVERSAL SERVICE TOOL



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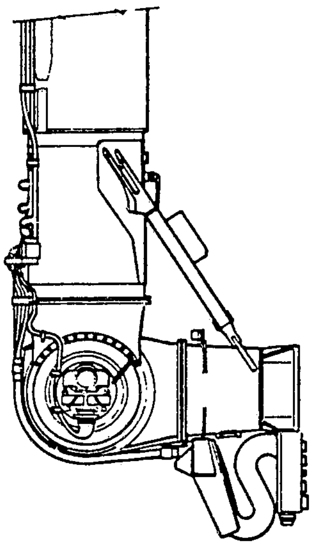

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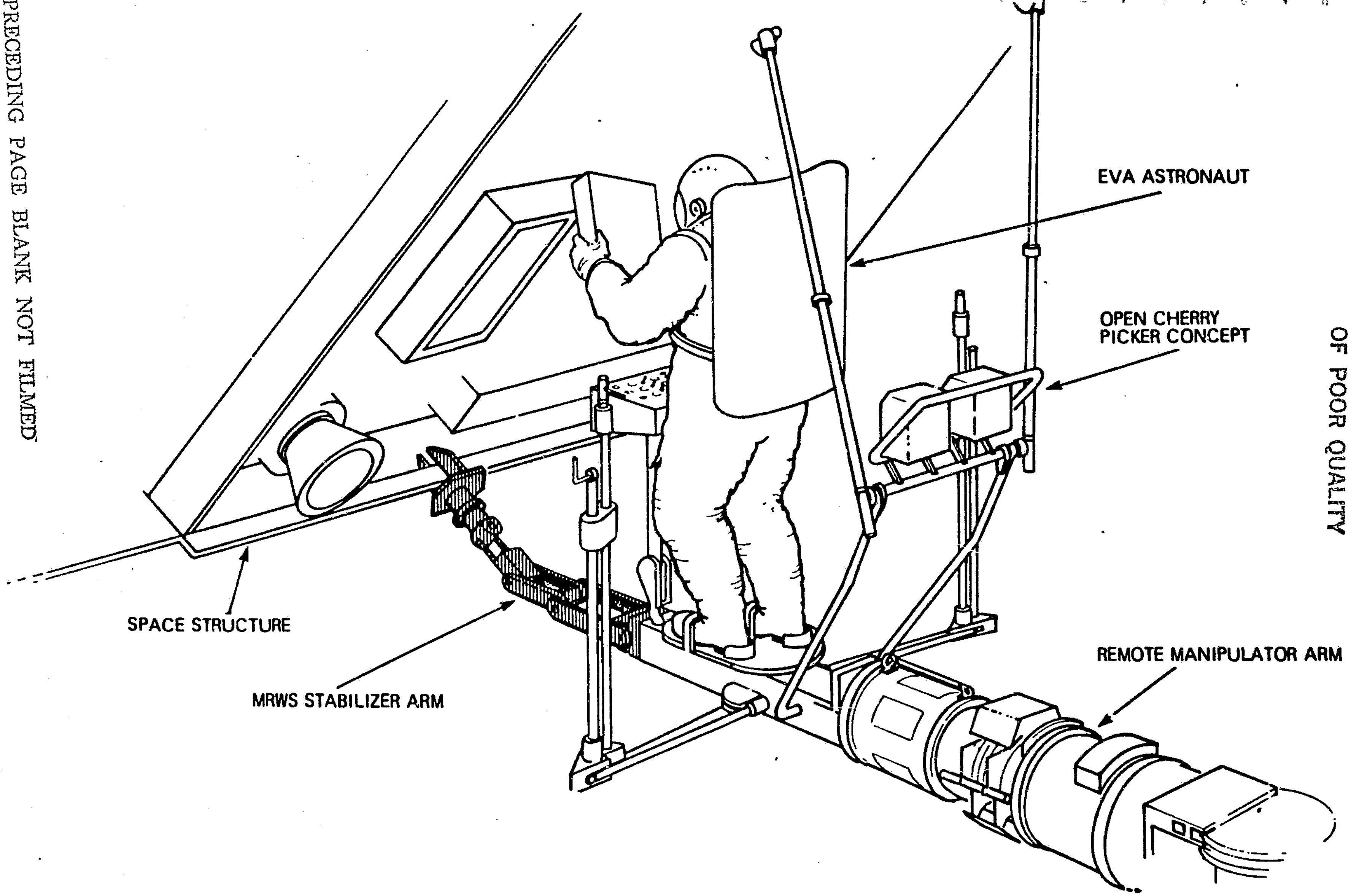

FIG. 5 MRWS OPEN CHERRY PICKER/STABILIZER ARM/RMS CONCEPT

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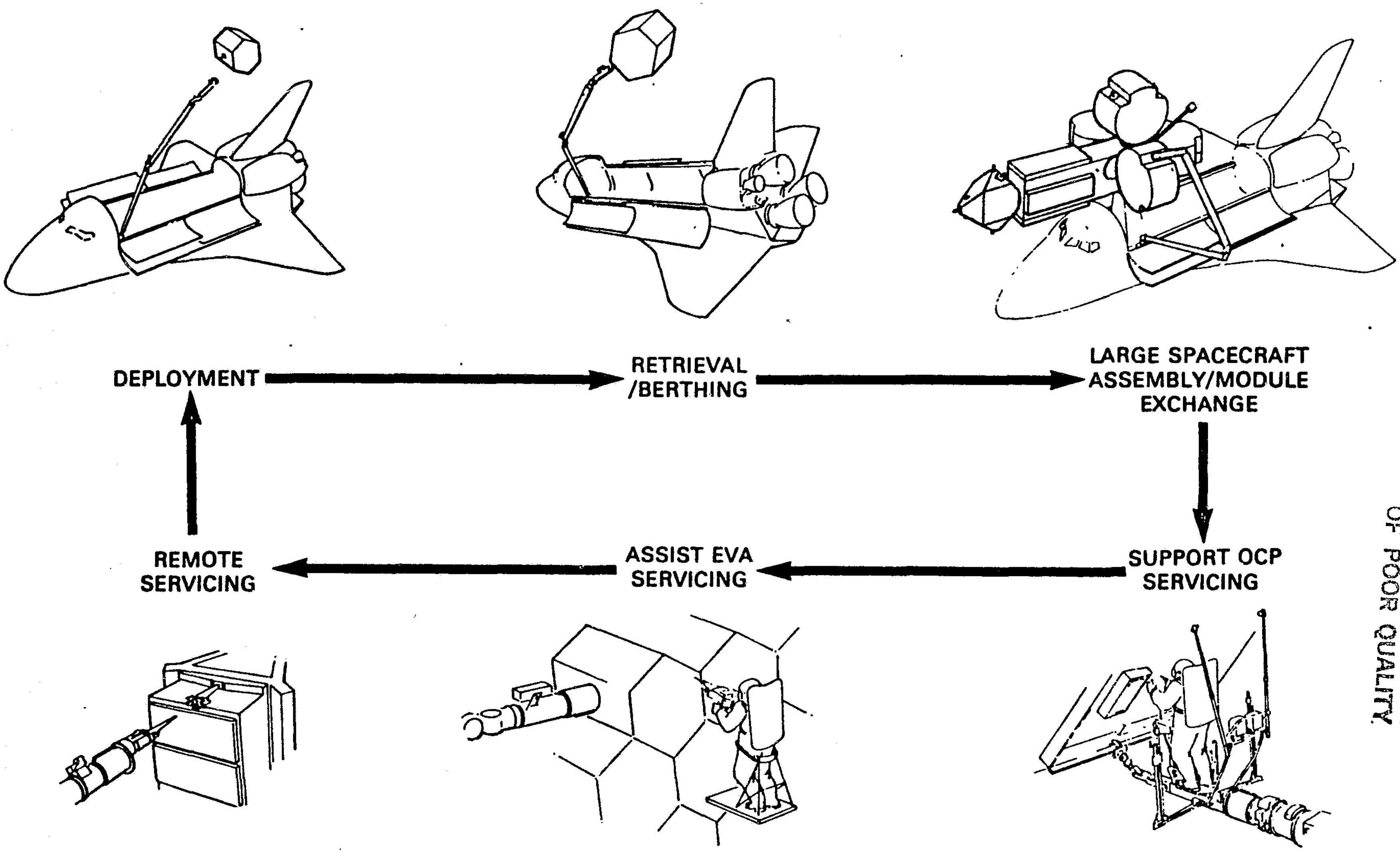
THE ROLE OF SRMS IN SATELLITE SERVICING

SPAR

SRMS TASKS



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APPENDIX E

SPACE STATION ARCHITECTURE - LOCKHEED
- B. THOMAS STRAWMAN

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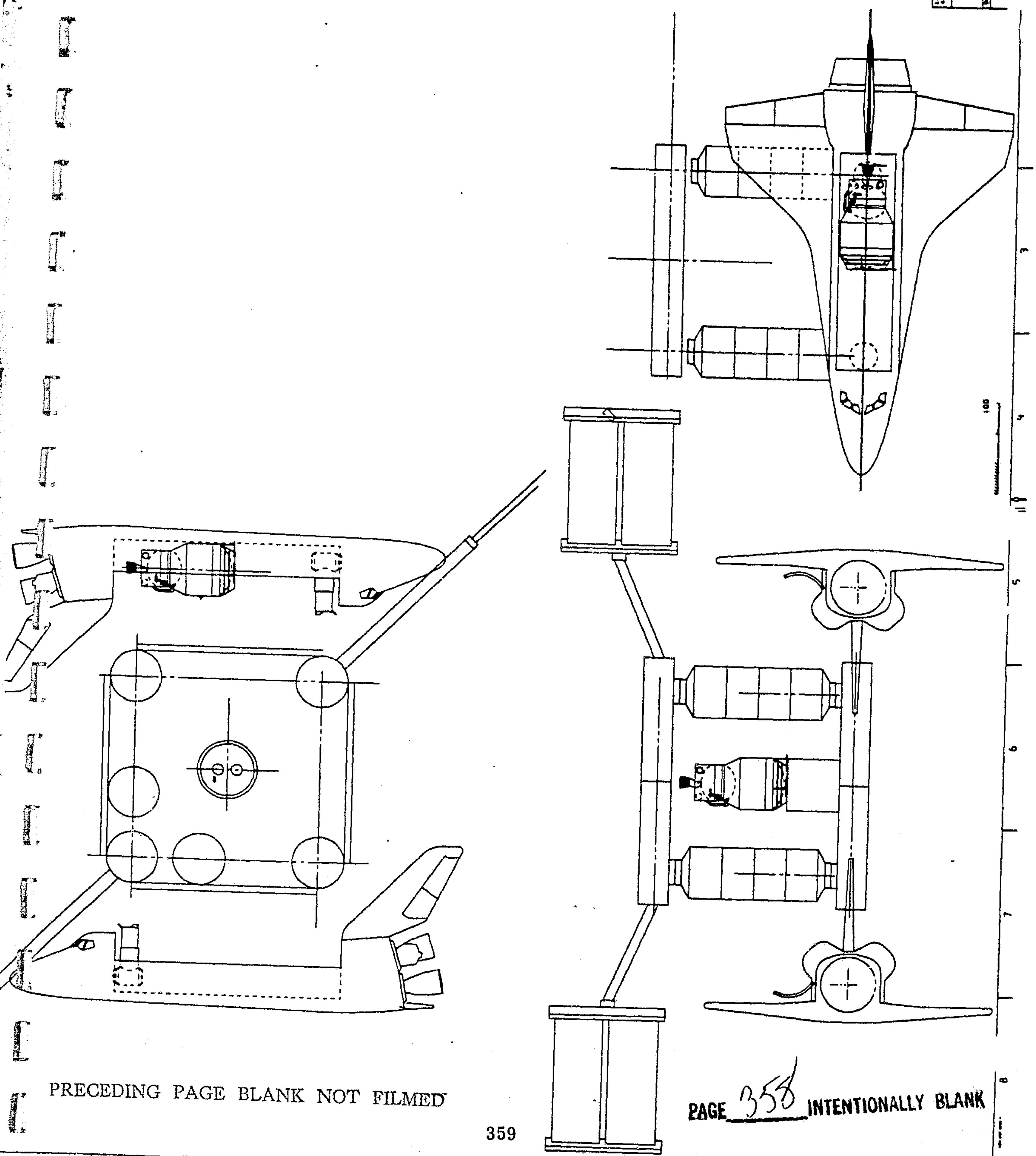

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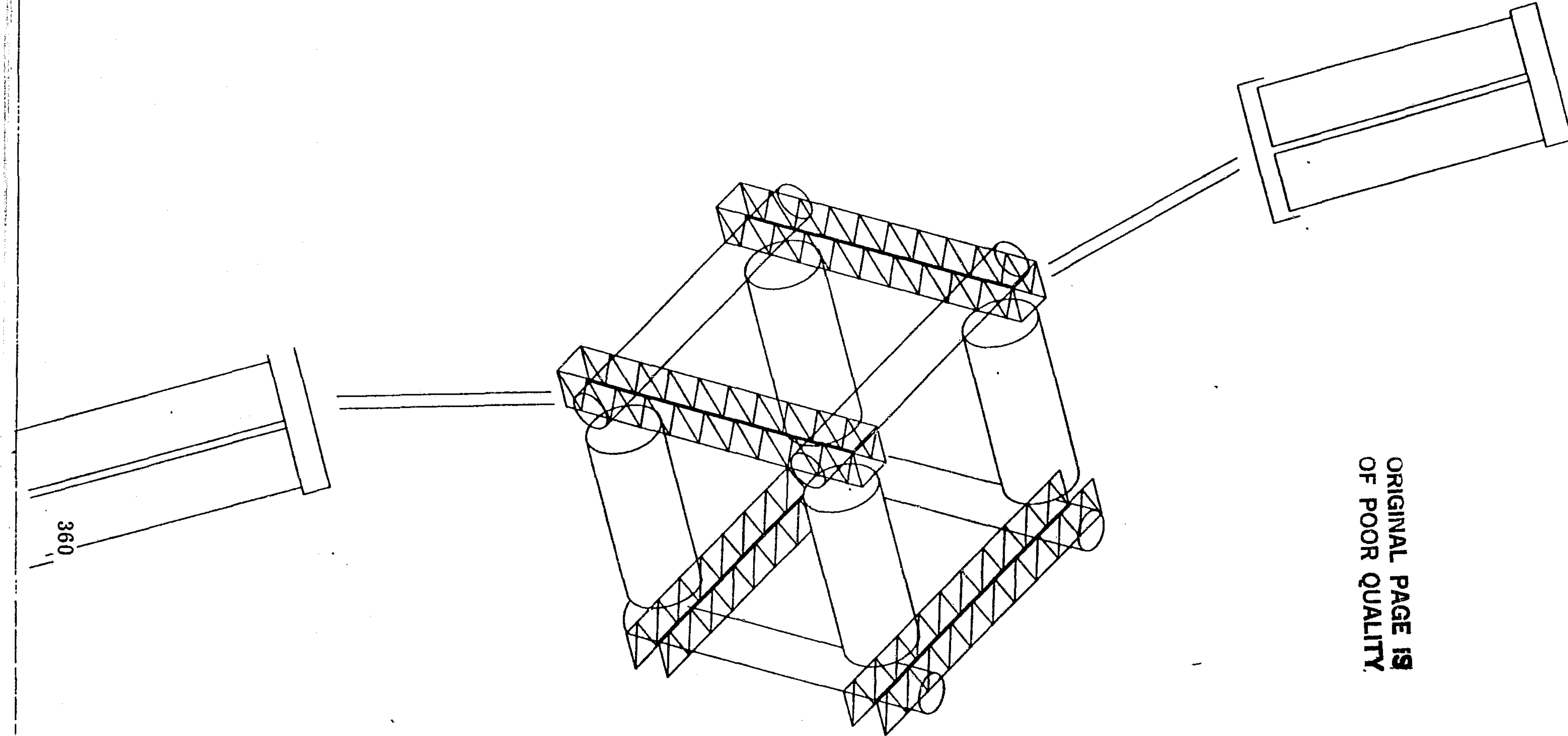

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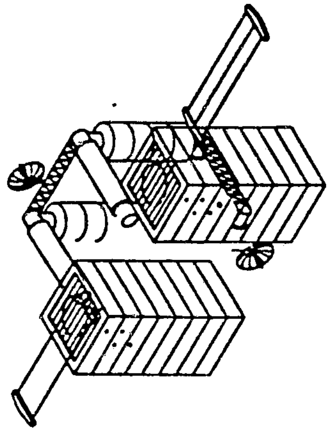
LOCKHEED MISSILES & SPACE COMPANY, INC.
A SUBSIDIARY OF LOCKHEED AIRCRAFT CORPORATION
SUNNYVALE, CALIFORNIA

SS LAYOUT ISO

DWG & MODEL NO
SS.10.9



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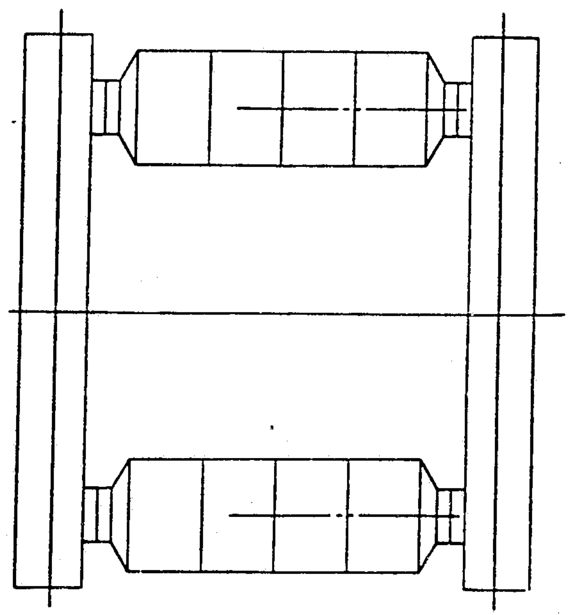

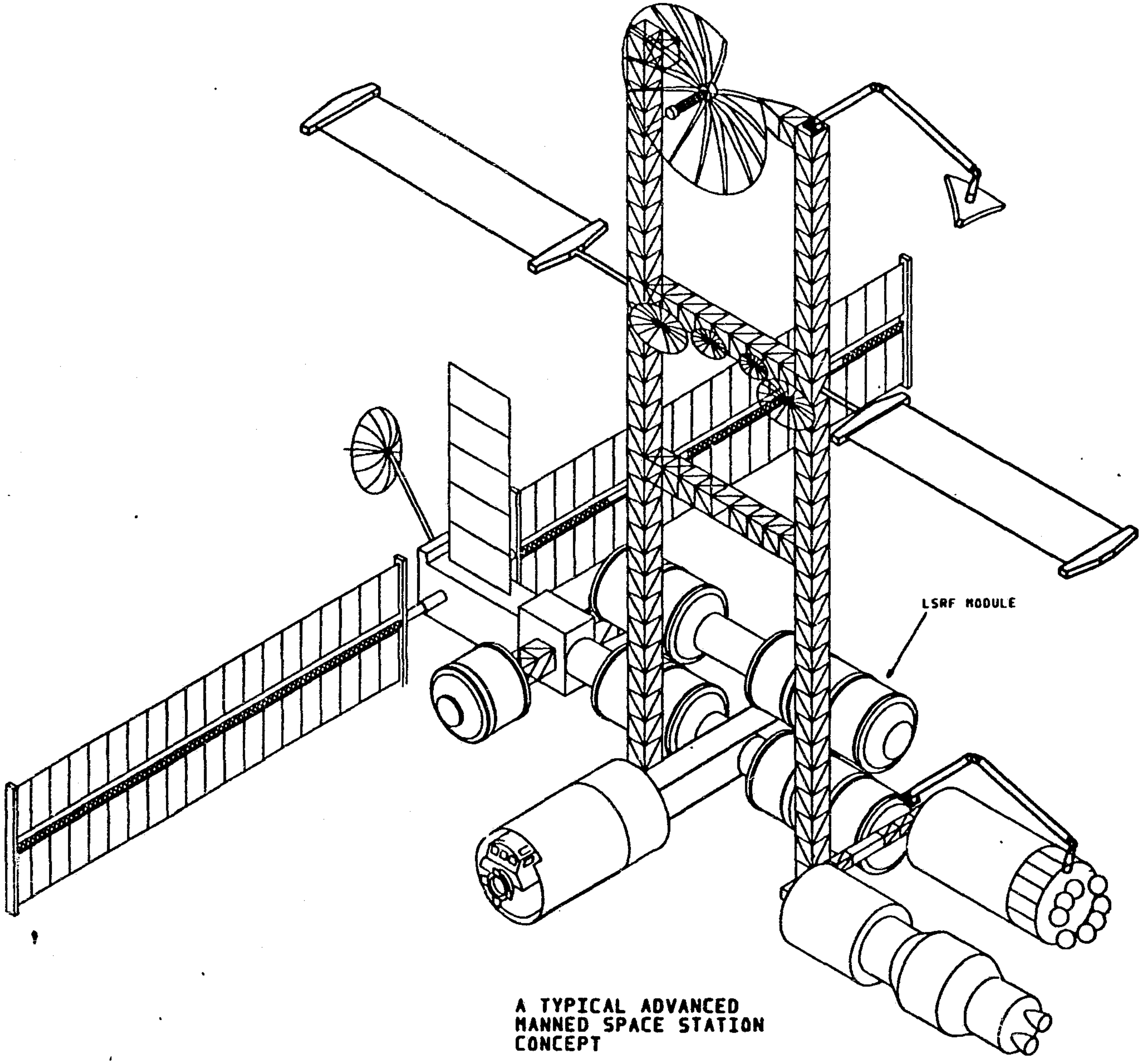

A TYPICAL ADVANCED
MANNED SPACE STATION
CONCEPT

LOCKHEED MISSILES & SPACE COMPANY, INC.

LSRF MAXIMUM
#2

LSRF.19

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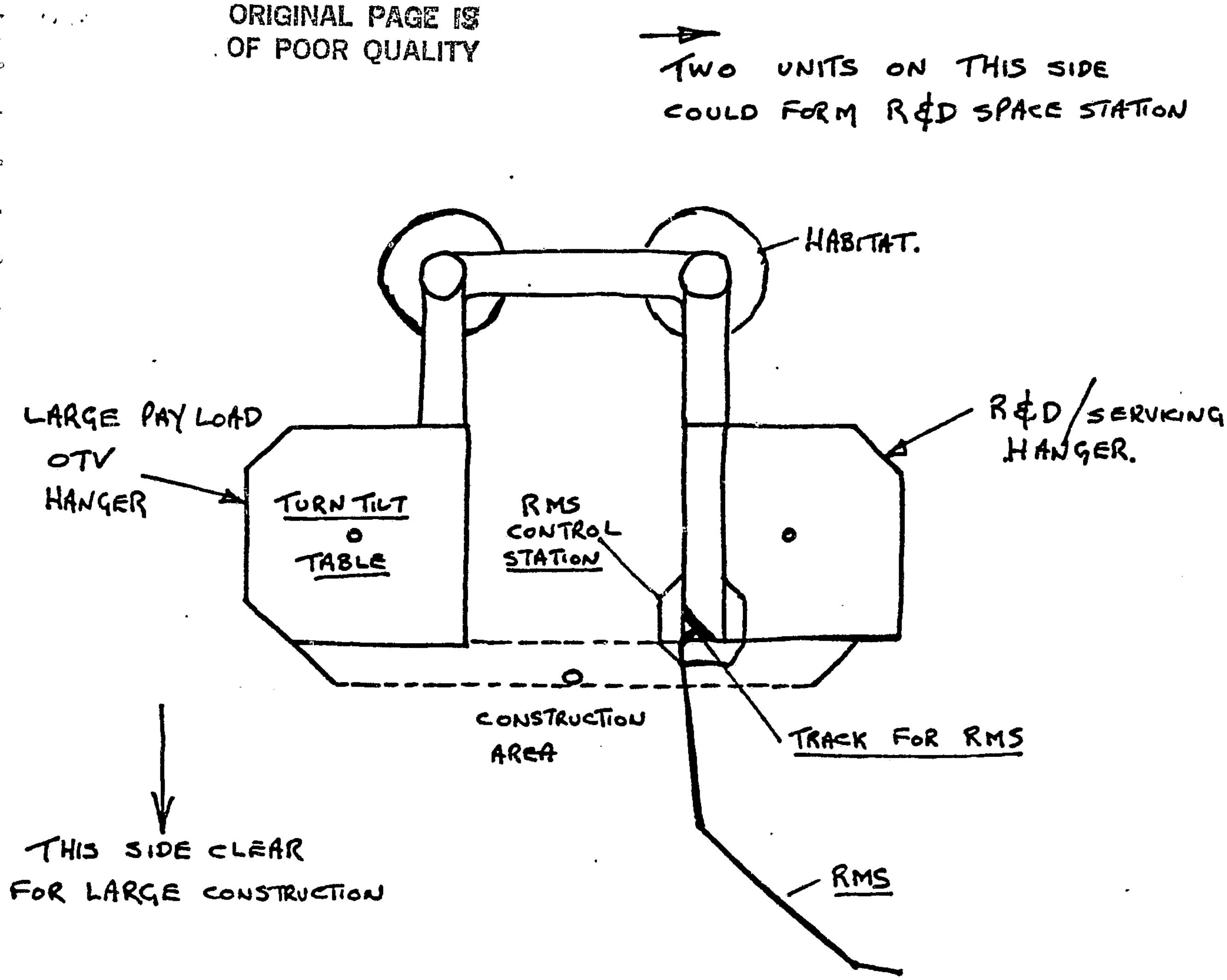

STRAW MAN SPACE STATION

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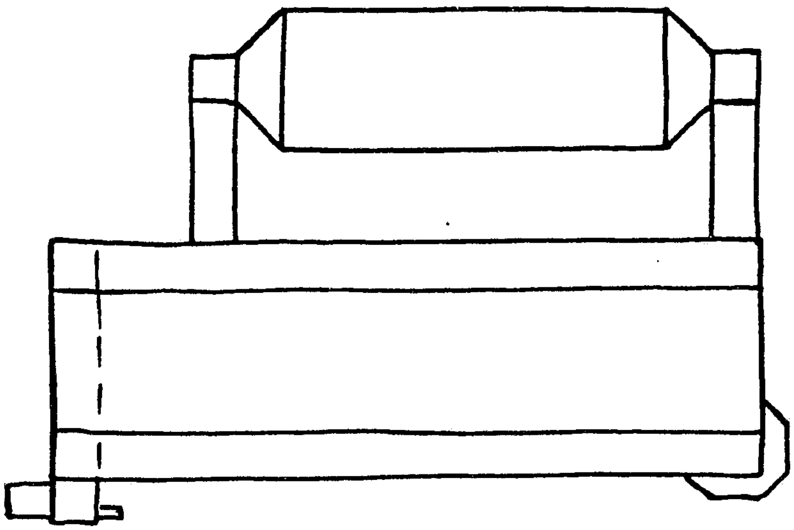

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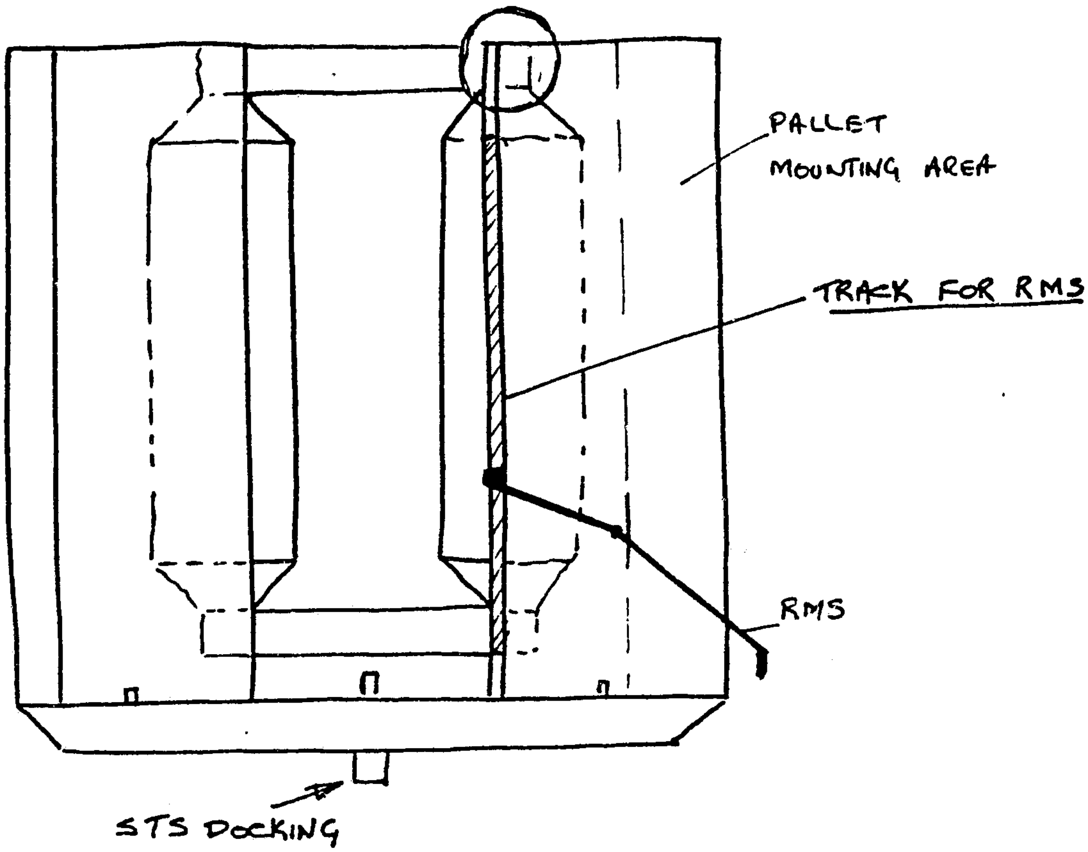

APPENDIX F

LOCKHEED GENERATED SPACE STATION
SCENARIOS

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INTERDEPARTMENTAL COMMUNICATION

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JAMES
B J Ramos 10.12.82

TO DISTRIBUTION DEPT./ORGN. BLDG./ZONE PLANT/FAC. DATE 24 November 1982

FROM K. J. Forsberg DEPT./ORGN. 61-87 BLDG./ZONE 577N PLANT/FAC. 5 EXT. 3-0544

SUBJECT REVIEW AND UPDATE OF SPACE STATION SCENARIOS

ENCLOSURE COPIES OF SCENARIOS (17) (Scenarios 1, 15 and 16 not included)

1. Seventeen scenarios (enclosed) have been developed for the Space Station Needs study. At the Study mid-term review with NASA (15 November), Lockheed identified these scenarios to be the candidate missions for the five mission categories to be discussed with potential users. At this time, we need to review and complete these scenarios so that they can be effective for developing the user requirements.

2. Please review the scenarios for your area of specialization, and add information to complete the descriptive data. Specifically where contacts have not been identified, provide a minimum of two names which you recommend. (It may be helpful for you to confirm your recommended contact by a telephone call to that person.) Remember that the scenarios should be reviewed by you with the contact person you have identified to solicit concurrence and needs data. Also provide data on specific sensors (types) and instrument and/or data characteristics which are pertinent to achieve the mission objective. Further, please attempt to time phase the mission in terms of when it could be implemented within the 1990-2000 era. Scenarios number 15 (On Orbit Satellite Servicing in HEO) and number 16 (Large Satellite Assembly) need to be written in the format of the other scenarios. (T. Fisher to take action on this.) Please date and sign your review copies and forward to Bill James, Orgn/61-87, Ext. 3-1362 by 03 December 1982.

3. Reponsibilities for review and comment on the scenarios is as follows:

0. Base Station

~~1.~~	~~Orbiting~~ National Command Post ~~(Classified)~~	~~Forsberg~~
2.	Oceanography Observatory Development Laboratory	Forsberg
3.	Space Observation Development Laboratory	Forsberg
4.	Earth Habitability Observatory Laboratory	Straight
5.	Celestial Observatory	Vondrak
6.	Space Environment Facility	Vondrak
7.	Earth Observation Facility	Straight
8.	Material Processing Research Laboratory	Grodzka
9.	Material Processing Facility	Grodzka
10.	Non-Human Research Laboratory	Olcott
11.	Human Research Laboratory	Olcott
12.	Meteorological Facility	Straight
* 13.	Space Objects Identification System	Forsberg
14.	On-Orbit Satellite Servicing in LEO	Fisher
~~15.~~	~~On-Orbit~~ Satellite ~~Servicing in HEO~~	~~Fisher~~
~~16.~~	~~Large~~ Satellite ~~Assembly~~	~~Fisher~~
17.	Space Platform Servicing - Free Flyer	Fisher

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IDC to Distribution
FROM: K.J. Forsberg
SUBJ: REVIEW AND UPDATE OF SPACE STATION SCENARIOS
DATE: 24 November 1982

4. Your prompt attention to this review is required.

for D D Smith
K. J. Forsberg
Program Manager
Manned Space Station

EWW:bj

cc: T. Fisher
P. Grodzka
T. Olcott
W. Straight
R. Vondrak

SPACE STATION PROGRAMS

ATTACHMENT 2

SUPPORTING DATA AND ANALYSIS REPORTS

VOLUME I

HAMILTON STANDARD

Lockheed

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Frederick M. Rogers
Field Representative

UNITED
TECHNOLOGIES
HAMILTON
STANDARD

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415/876-5597
415/876-4667

UNITED TECHNOLOGIES
HAMILTON
STANDARD

Windsor Locks, Connecticut
203/623-1621

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2 June 1982
1A-2-6

Lockheed Missiles and Space Company, Inc.
P.O. Box 504
Sunnyvale, CA 94086

Attention: Mr. Robert Stegman

Subject: "Definition of Technology Development Missions for Early Space Station"

Reference: NASA/MSFC RFP No. 8-1-2-PP-01147, May 5, 1982

Gentlemen:

Hamilton Standard offers to provide study support to Lockheed in your conduct of the Definition of Technology Development Missions For Early Space Station Study Program. Our efforts would include the Extravehicular Activity (EVA) interface analysis required to allow EVA optimization during each stage of space station development. Hamilton Standard will identify key areas of EVA, namely space station berthing dock development, on-orbit EVA structures/satellite support equipment and refurbishment, satellite servicing and construction procedures and timelines, and other factors associated with EVA. Early implementation of these EVA factors is essential for a smooth transition from early space station operations to an increased activity permanently manned operations base.

Hamilton Standard proposes to provide the following support for each of the key space operations identified in the referenced RFP.

Section A - Large Space Structures

Current programs on space structure construction have provided insight into structural design and deployment sequences/operations. EVA has been successfully incorporated in large space structure construction and proven to be a critical factor in establishing on-orbit construction missions. In order to accurately define the time-phased capabilities (deployment, assembly, erection, and construction) required of the Evolutionary Technology Plan, EVA must be incorporated and developed along with the space station to determine the optimal modes of operation in manned or automated operations, establish mission timelines, and evolve manpower and related support equipment requirements. Hamilton Standard will identify all aspects of EVA, recommend equipment and operations, and support space station evolutionary design concepts as necessary to support construction of large space structures.

Section B - Satellite Servicing

Satellite servicing is scheduled to become a key operation from the space station, with EVA already being established as a key aspect of satellite servicing (vis-a-vis JSC studies). Hamilton Standard has studied satellite servicing extensively, especially in areas of cabin-airlock-worksite interfaces, man/machine interfaces, operational procedures and timelines, EVA optimization, and on-orbit support equipment plus relative refurbishment requirements. Integration of these parameters shall assure that space station design evolves in accordance with satellite servicing mission objectives. Hamilton Standard will draw from a comprehensive satellite servicing data base to create an innovative, acceptable space station EVA system for satellite servicing. Assembly of spacecraft, while operationally different than satellite servicing, will utilize the same EVA support equipment and present analogous refurbishment requirements.

Section C - Orbital Transfer Vehicles (OTV)

Both early orbital transfer vehicles and second generation manned OTV's will require specific space station design features for the OTV and payload. These design features will progress from unmanned OTV berthing, prelaunch/post-launch processing, payload integration, and propellant storage and transfer to manned OTV operations requiring additional structures for crewmember safety, transgression and man/machine interfacing.

Actual checkout and servicing of the OTV will follow operations and require equipment similar to satellite servicing concepts, yet present unique conditions (refueling, berthing, refurbishment) which may change as space station evolves.

Hamilton Standard would apply EVA integration, operations, applications and considerations which define requirements, approaches, and innovations for supporting the development effort for any or all of the three RFP sections.

As the supplier of the Space Shuttle Extravehicular Mobility Unit (EMU), Hamilton Standard is the major source of study data for the use and application of this device and ancillary equipment in space applications such as those being investigated under the subject program. Our experience and credentials for this support offer includes three major space suit system hardware programs - Apollo, USAF Manned Orbiting Laboratory, and the current Space Shuttle EMU and over 15 similar and related EVA and space operations contracted studies. Within this background are the most current space operations and satellite servicing studies, specialized space devices operable and serviceable via EVA operations, advanced EMU related technology studies and developments, and extravehicular crewman work systems.

We envision our study support efforts to include systems and concepts analysis and extrapolations, new data generation and new concepts development. The costs for this task shall be mutually negotiated upon clear definitions of the work scope required.

We look forward to participation with Lockheed and we feel that we have a significant contribution to make to the Lockheed program. If you should have any questions please feel free to call Mr. Merlin A. Shuey or Mr. A. O. Brouillet at (203)623-1621, X-5491 or X-4656 respectively.

Very truly yours,

HAMILTON STANDARD
Division of United Technologies Corporation

Thomas W. Herrala

Thomas W. Herrala
Manager-New Business